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NASA Program Apollo Working Paper No. 1127

PROGRAM APOLLO FLIGHT MISSION DIRECTIVE

FOR SECOND SATURN/APOLLO LAUNCH EXIT ENVIRONMENT

APOLLO MISSION A-102

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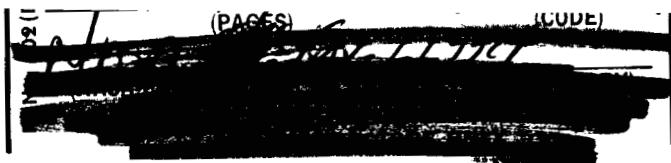
(BP-15)

(NASA-TM-X-66774) PROGRAM APOLLO FLIGHT
MISSION DIRECTIVE FOR SECOND SATURN/APOLLO
LAUNCH EXIT ENVIRONMENT APOLLO MISSION A-102
/BP-15/ (NASA) 94 p

011101/15 N79-76198

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HOUSTON, TEXAS

June 30, 1964

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NASA PROGRAM APOLLO WORKING PAPER NO. 1127
PROGRAM APOLLO FLIGHT MISSION DIRECTIVE
FOR SECOND SATURN/APOLLO LAUNCH EXIT ENVIRONMENT

APOLLO MISSION A-102

(BP-15)

[U]

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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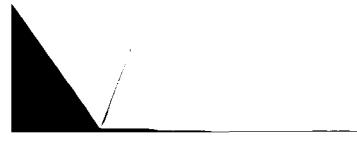
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LIST OF ABBREVIATIONS AND SYMBOLS

The following list includes all abbreviations used throughout this document.

a-c	alternating current
accel.	accelerometer
amp (AMP)	amplifier
ASPO	Apollo Spacecraft Program Office
ATR	Apollo Test Requirement
BP	boilerplate
C	Centigrade
calib	calibration
c.g.	center of gravity
CM	command module
COM	commutated
COM SEG	commutator segment
cps (CPS)	cycles per second
CT	continuous
deg (DEG)	degrees
°	degrees, latitude or longitude
DIA (diam)	diameter
d-c	direct current
° C (DEG C)	degrees Centigrade
° F (DEG F)	degrees Fahrenheit
ECS	environmental control subsystem
E. O.	engineering order

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EMI	electromagnetic interference
EPS	electrical power subsystem
ETR	Eastern Test Range
FM	frequency modulation
ft	feet
ft/sec (fps) (FPS)	feet per second
g (G)	gravitational constant, 32.2 ft/sec ²
GSE	Ground Support Equipment
GN ₂	gaseous nitrogen
h	altitude, feet
hr (Hr)	hours
IU	Instrument Unit
in.	inches
I _X	moment of inertia along X-axis
I _Y	moment of inertia along Y-axis
I _Z	moment of inertia along Z-axis
JB	junction box
KSC	Kennedy Space Center
LE	launch-escape
LES	launch-escape subsystem
LET	launch-escape tower
lb	pounds
lb/ft ²	pounds per square foot
LH ₂	liquid hydrogen

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LK	link
LOX	liquid oxygen
L/V	launch vehicle
mc (MC)	megacycle
Meas. ID	Measurement identification
min	minutes
MSC-FO	Manned Spacecraft Center - Florida Operations
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
PCB	power-control box
POD	Prelaunch Operations Division
psia (PSIA)	pounds per square inch absolute
psid (PSID)	pounds per square inch differential
pyro	pyrotechnics
q(Q)	dynamic pressure, lb/sq ft
R	range
RCS	reaction control subsystem
R&D	research and development
RFI or rfi	radio frequency interference
RP-1	kerosene
SC	signal conditioner
SC no.	subcarrier number
SCB	signal conditioner box
SCO	subcarrier oscillator
S/C	spacecraft

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sec	second
SM	service module
S/S	samples per second
t	time, sec
Temp. (temp.)	temperature
TM (T/M)	telemeter
v	volts
v d-c	volts direct current
v a-c	volts alternating current
V	velocity
VHF	very high frequency
vswr (VSWR)	voltage standing wave ratio
X _a , Y _a , Z _a	X-, Y-, Z-axis locations on over-all spacecraft
X _A	X-axis location on adapter
X _C	X-axis location on command module
X _L	X-axis location on launch-escape system
X _S	X-axis location on service module
μ sec	microseconds
γ	flight-path angle, deg

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1-1

1.0 INTRODUCTION

1.1 Purpose of the Mission

The primary purpose of this mission, designated Apollo Mission A-102, is the continuing development of the Saturn I launch vehicle. The payload on the launch vehicle will be the Apollo spacecraft which consists of a command module, with a launch-escape subsystem, a service module, and adapter. This Apollo spacecraft, designated BP-15, has the weight and external shape planned for the production Apollo spacecraft. However, BP-15 has a relatively massive non-production structure and has only a minimum of subsystems on board. The BP-15 spacecraft is identical in all major construction and subsystem configuration respects to the BP-13 spacecraft which was flown on Apollo Mission A-101 utilizing the SA-6 launch vehicle.

The two primary differences between the BP-13 and BP-15 spacecraft are in the method of jettisoning the escape tower, and in the instrumentation. The launch-escape tower was jettisoned by way of the tower-jettison motor on BP-13, whereas on BP-15 the launch-escape tower will be jettisoned by firing the launch-escape and pitch-control motors. The other difference is in the instrumentation. BP-15 will have one of the reaction-control subsystem (RCS) quads, located near the -Z axis, instrumented with 16 temperature transducers, and 2 vibration transducers.

Since Apollo Mission A-101 was successful (see MSC report MSC-R-A-64-2) and the launch and exit flight environments for the spacecraft were measured satisfactorily, the measurement of these environments now becomes of secondary importance for Apollo Mission A-102. Thus, for this mission A-102, the spacecraft does not have any first-order mission objectives.

Apollo Mission A-102 will be the second flight of the combination of an Apollo spacecraft and a Saturn I type launch vehicle. As in Apollo Mission A-101, this spacecraft (BP-15) will also remain attached to the launch vehicle second stage (S-IV) upon insertion into orbit with no recovery planned. For normal orbital insertion conditions, the BP-15 spacecraft and attached S-IV tankage will be expected to reenter the earth's atmosphere sometime after the third day but prior to the seventh day in orbit; reentry for Apollo Mission A-101 occurred about the middle of the fourth day of orbit. The orbital trajectory planned for BP-15/S-IV is approximately circular at an altitude of 100 nautical miles.

1.2 Purpose of the Mission Directive

The purposes of this Mission Directive are:

- (a) To specify test objectives, describe vehicle configuration and system priorities, describe flight trajectories, data, and instrumentation requirements for boilerplate 15 testing.

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(b) To provide information required by the Eastern Test Range (ETR) for planning the subject flight. The detailed range facilities requirements, logistics support requirements, and range contractor requirements are beyond the scope of this report and are contained in the Operations Requirements No. 2400 for boilerplate 15 (ref. 1).

1.3 Precedence of Reports

The Flight Mission Directive supplements the NASA Apollo Program General Test Plan and shall take precedence over all other documents concerning this flight with respect to the payload (S/C). The Flight Mission Directive will also supplement the Apollo Flight Mission Assignment document. (ref. 2)

1.4 Amendments

This document will be revised if necessary to reflect any major changes in the test plan.

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2.0 SPACECRAFT TEST OBJECTIVES AND SYSTEM PRIORITIES

2.1 General

The reason for using an Apollo spacecraft for the A-102 Mission is to provide the proper weight and aerodynamic shape for the front end of the launch vehicle. The spacecraft, therefore, does not intrinsically have any first-order objectives.

2.2 Test Objectives

2.2.1 First-order test objectives for the spacecraft. - None

2.2.2 Second-order test objectives for the spacecraft. - The second-order objectives are:

(a) Determine the launch and exit environmental parameters to verify design criteria.

(b) Demonstrate the alternate mode of spacecraft escape tower jettison utilizing the launch-escape motor and the pitch-control motor.

2.3 Subsystem Priorities

2.3.1 Launch-escape subsystem. - The priorities of the launch-escape subsystem are:

(a) Launch-escape motor Primary

(b) Pitch-control motor Primary

2.3.2 Electrical power subsystem (EPS). - The priority of the electrical power subsystem is:

Battery power subsystem Primary

2.3.3 Communications and instrumentation subsystem. - The priorities of the communication and instrumentation subsystem are:

(a) Telemeter and antenna subsystem Secondary

(b) Radar beacons Secondary

(c) Instrumentation Secondary

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2-2

2.3.4 Environmental control subsystem (ECS).- The priority of the environmental control subsystem is:

Temperature control	Secondary
---------------------	-----------

2.3.5 Sequencer subsystem.- The priorities of the sequencer subsystem are:

(a) Mission sequencer	Primary
-----------------------	---------

(b) Tower sequencer	Primary
---------------------	---------

2.3.6 Launch-escape-tower (LET) release subsystem.- The priority of the launch-escape-tower release subsystem is:

Single mode bolts	Primary
-------------------	---------

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3.0 MISSION DESCRIPTION

3.1 General Flight Plan

The Saturn-Apollo vehicle will be launched from Complex 37B with the vehicle pitch plane at an azimuth of 90° true and with a programmed roll to a flight azimuth of 105° true, prior to the start of the pitch maneuver. The Saturn I launch vehicle, designated SA-7, will consist of the S-1 first stage, S-IV second stage, and the Instrumentation Unit (IU). The flight configuration is shown in figures 3-1 and 3-2. Figure 3-3 shows a nominal flight profile from launch to orbit insertion indicating major events during the exit flight. The S-IV and the Apollo boilerplate 15 configuration will be inserted into a 100-nautical-mile circular orbit. The spacecraft telemetry subsystems will remain operating in orbit, although no orbital data are required. No recovery is planned.

3.2 Sequence of Events and Flight Parameters

The sequence of events and flight parameters from S-1 ignition through orbit insertion and S-IV cut-off are presented in table 3-1.

3.3 Trajectories

Nominal trajectory parameters are presented in figures 3-4 and 3-8 as follows:

Figure	Title
3-4	Boilerplate 15 earth orbital trace.
3-5	Boilerplate 15 boost trajectory earth trace. (Latitude plotted against longitude)
3-6	Time history of boilerplate 15 boost phase load factor, dynamic pressure, and attitude angle.
3-7	Time history of boilerplate 15 boost phase altitude, velocity, and flight-path angle.
3-8	Variation of boilerplate 15 boost phase altitude with range.

3.4 Flight Constraints

None

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TABLE 3-1.-BOILERPLATE 15 - SEQUENCE OF EVENTS AND FLIGHT PARAMETERS

Time, sec	Event	Earth-fixed velocity ft/sec	Altitude, ft	Earth-fixed flight-path angle, deg	Dynamic pressure, lb/ft ²	Mach number
T - 3.42	S-I ignition	0	0	90	0	0
T = 0	Lift-off	0	0	90	0	0
T + 69.5	Max q	1,481	38,770	58.7	720	1.5
T + 141.7	S-I inboard engine cut-off	8,212	198,187	25.8	28.3	7.9
T + 147.7	S-I cut-off, S-I/S-IV separation ignition, S-I/Village-rocket	8,718.3	219,886	24.8	11	8.9
T + 150.7	S-IV ignition	8,678.4	230,750	24.4	7	9.1
T + 160.7	Escape-tower jettison	8,752.5	265,581	22.8	1.3	10.3
T + 165.7	Initiation of optimum attitude control	8,799	282,272	22	0.5	10.4
T + 429.7	Peak altitude	14,563.5	667,567	0	0	-
T + 624.5	Orbit insertion, S-IV cut-off	24,242.3	607,609	0	0	-

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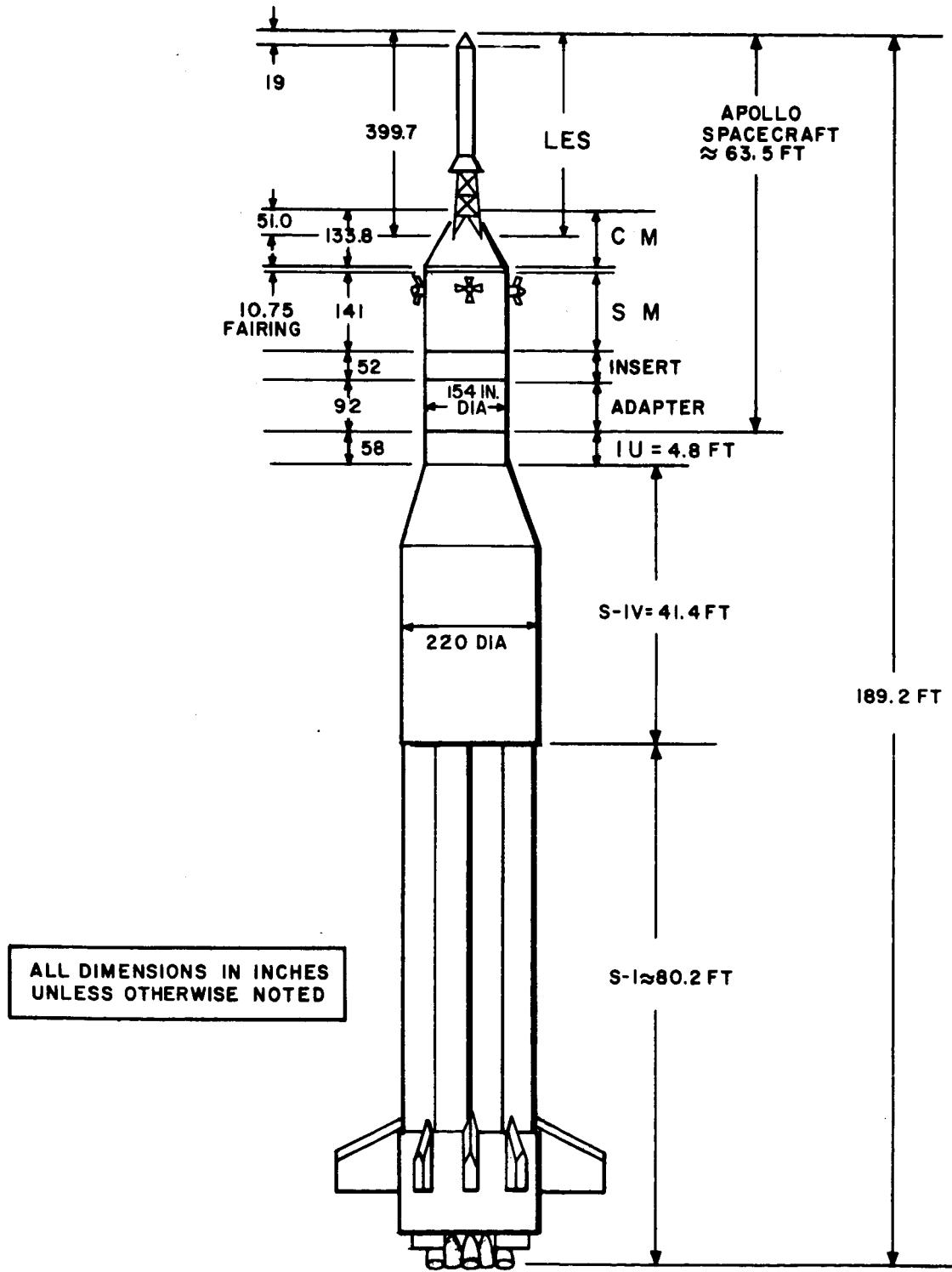


Figure 3-1.- Launch configuration.

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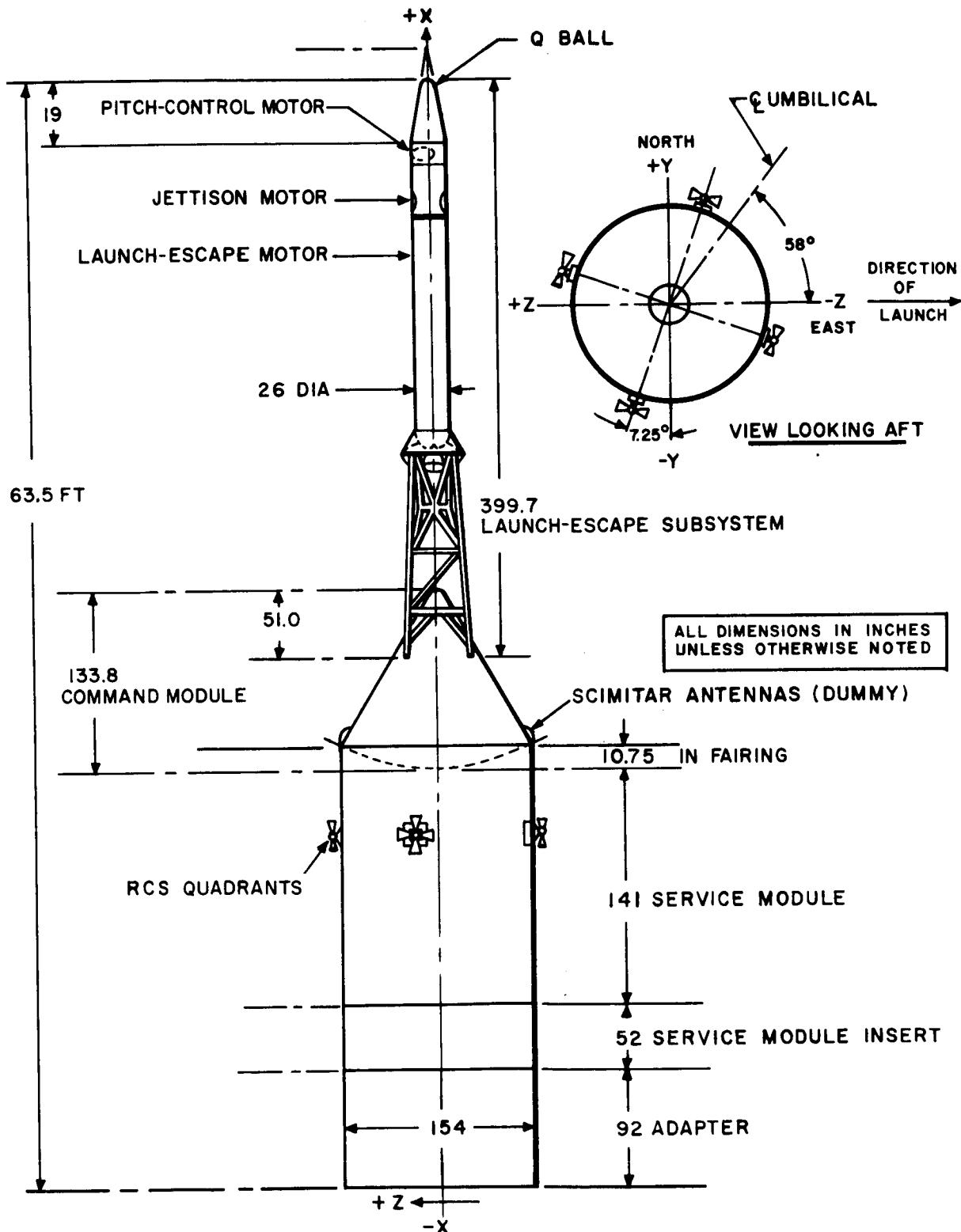


Figure 3-2.-Sketch of boilerplate 15.

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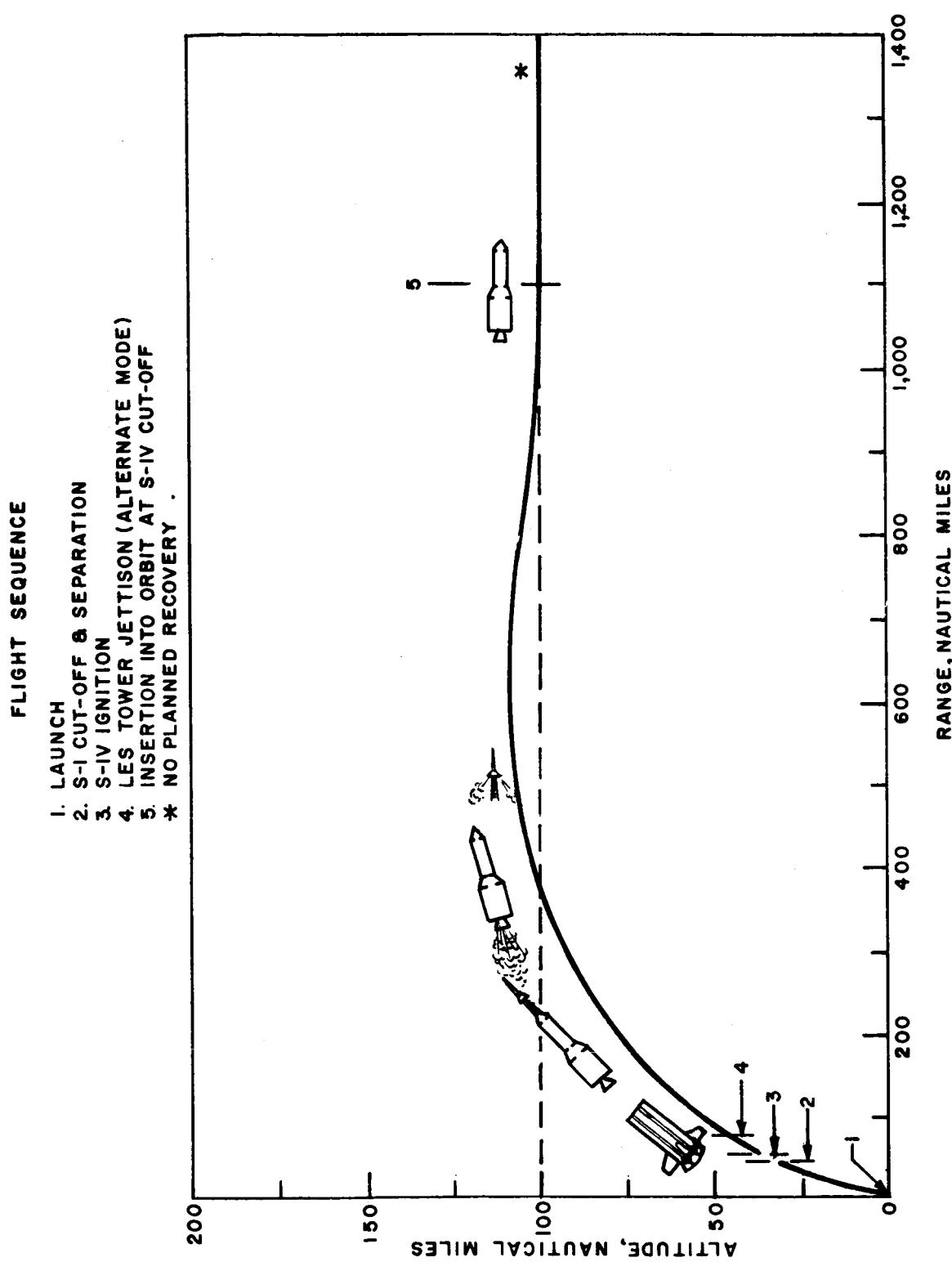
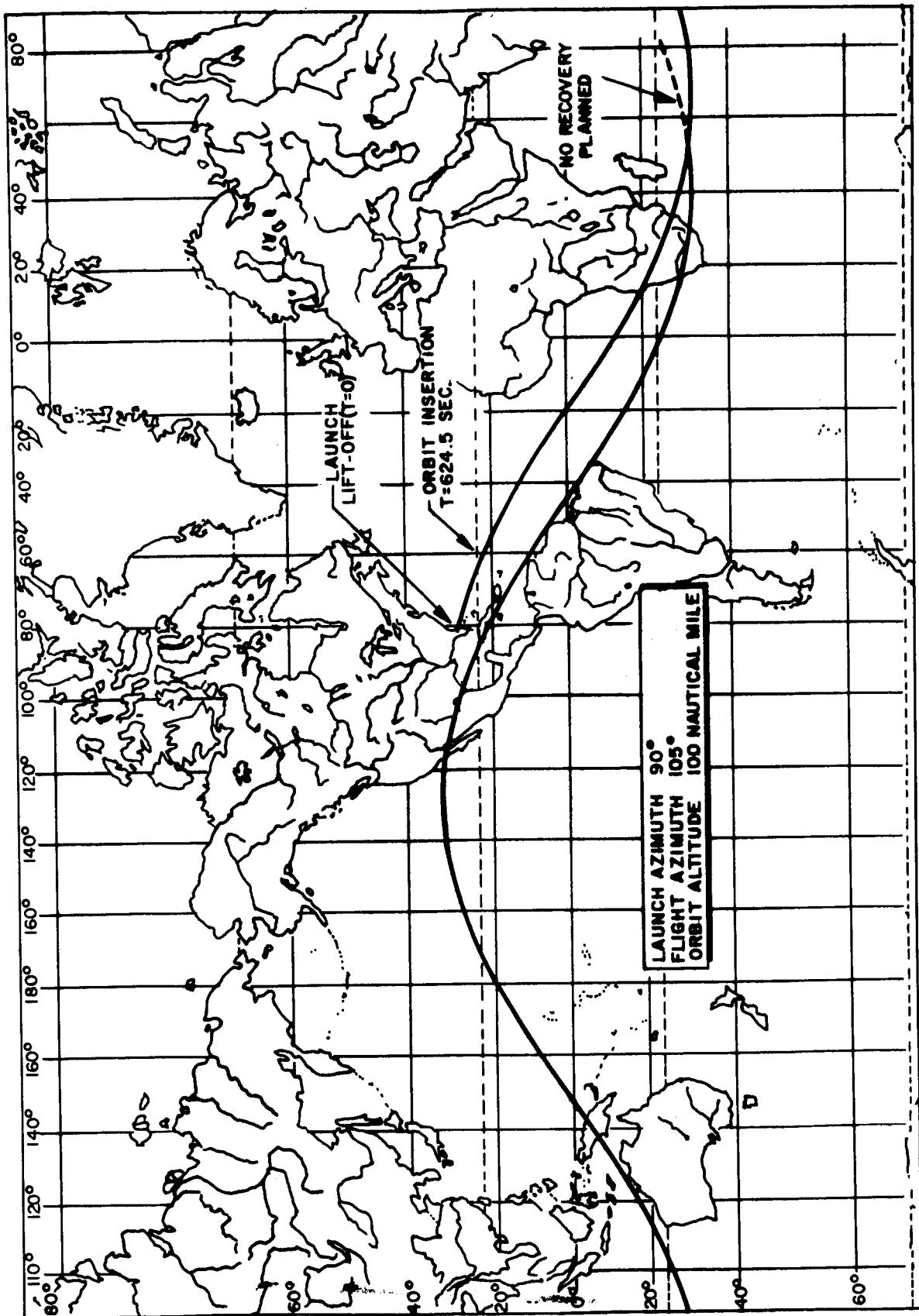


Figure 3-3.-Boilerplate 15 Mission launch profile.

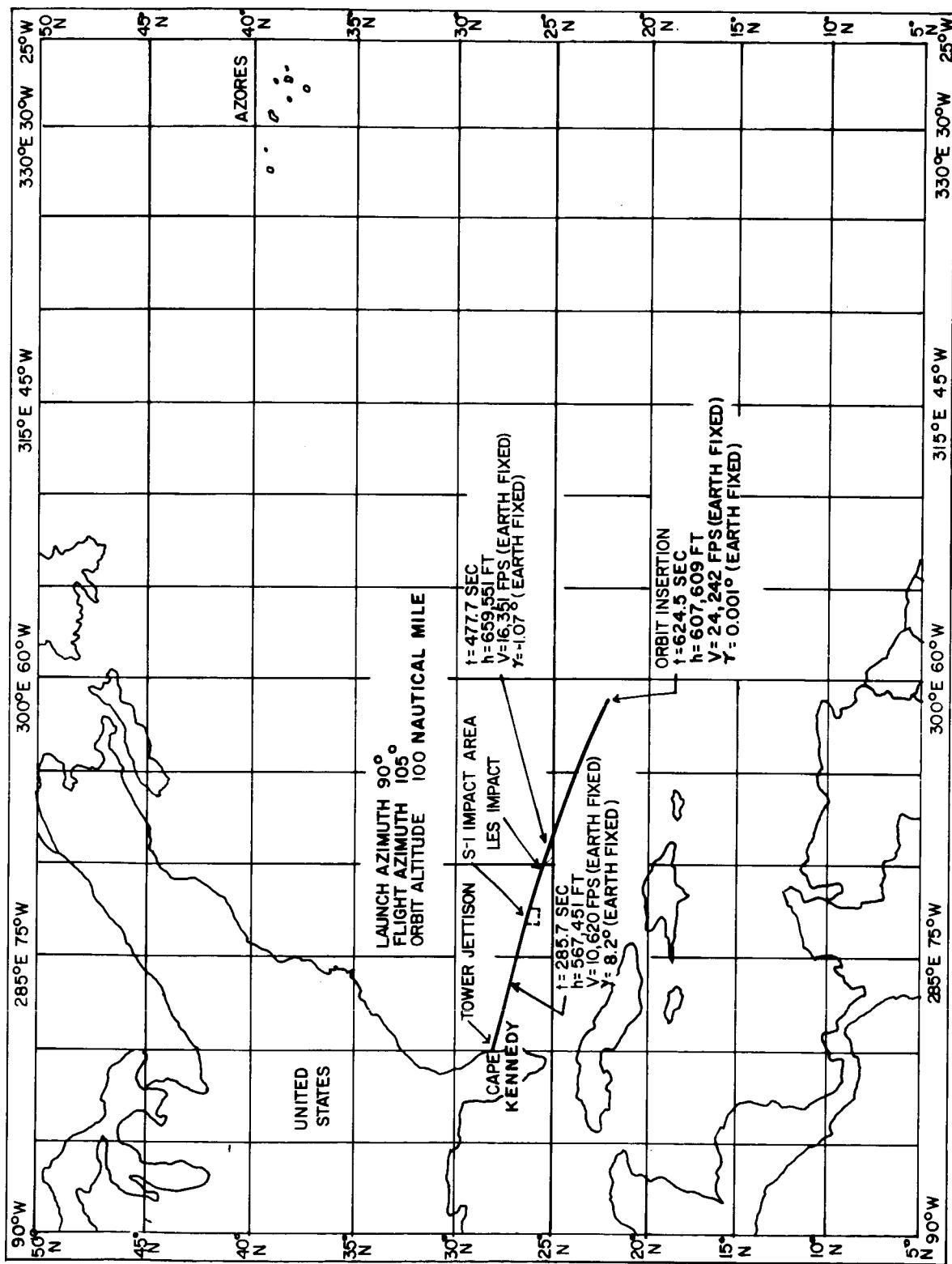
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Figure 3-4.-Boilerplate 15 earth orbital trace.

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Figure 3-5.-Boilerplate 15 boost trajectory earth trace (latitude plotted against longitude).

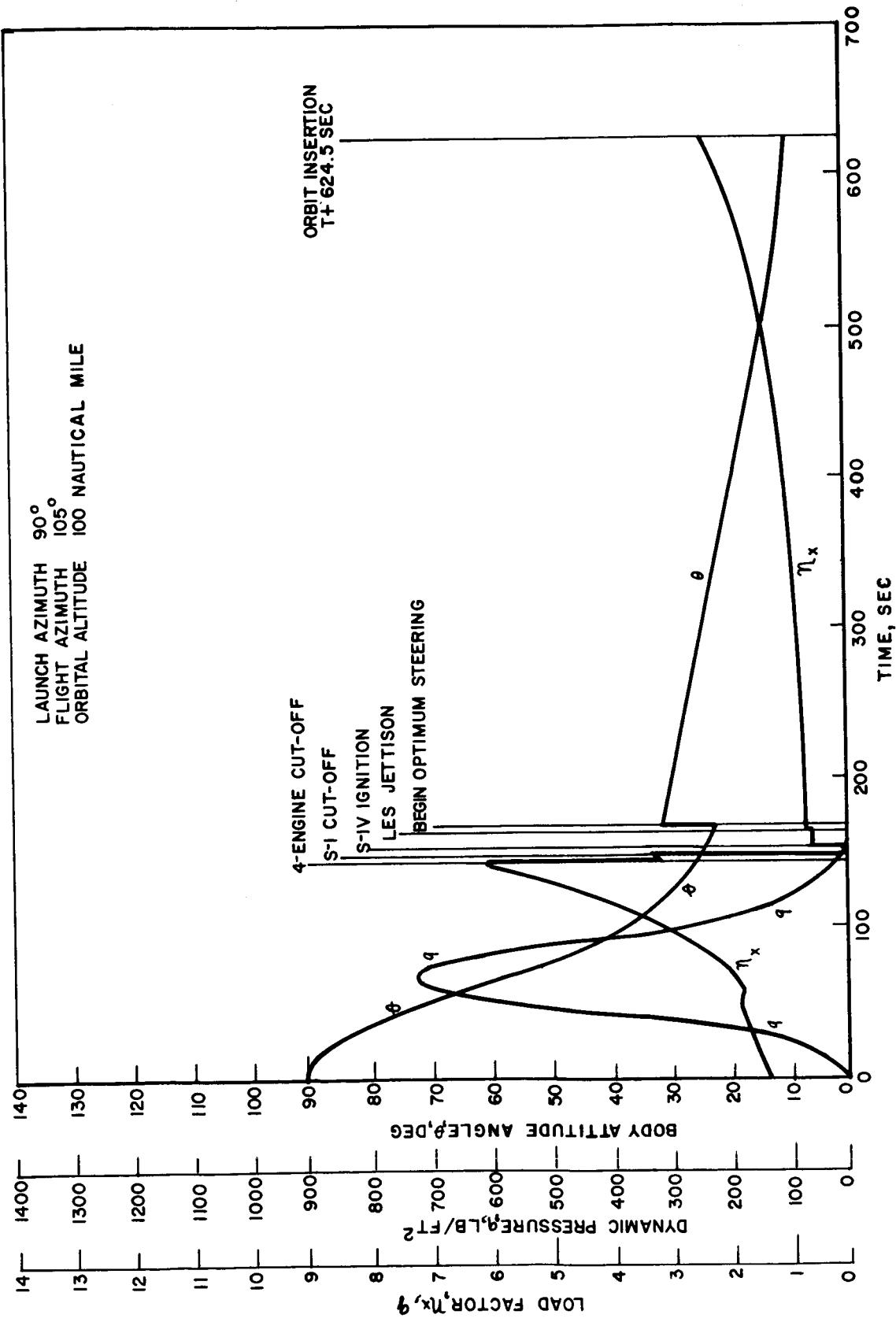


Figure 3-6.-Time history of boilerplate 15 boost phase load factor, dynamic pressure, and attitude angle.

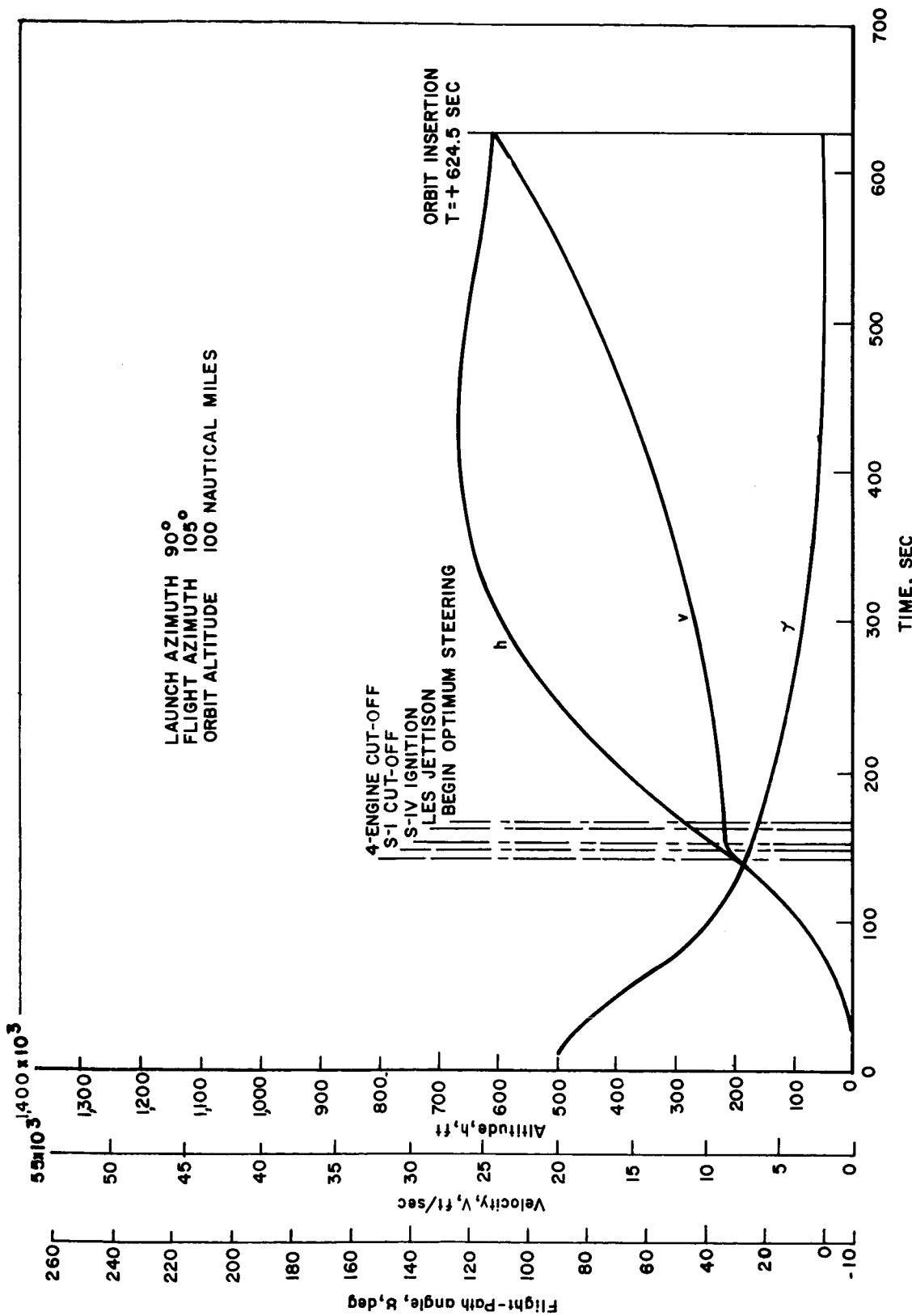


Figure 3-7.-Time history boilerplate 15 boost phase altitude, velocity, and flight-path angle.

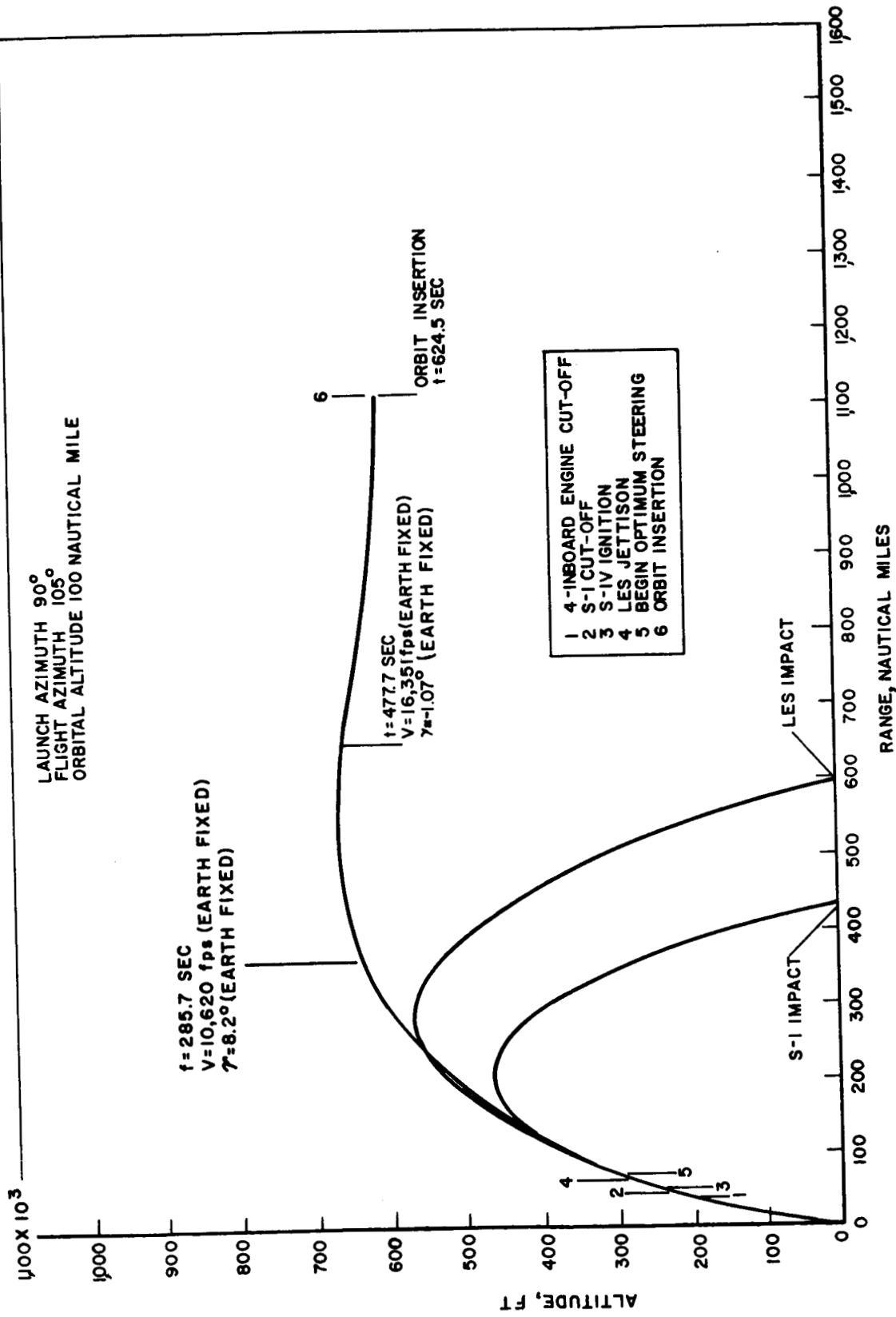


Figure 3-8.-Variation of boilerplate 15 boost phase altitude with range.

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4.0 DESCRIPTION OF TEST VEHICLE

4.1 Spacecraft Weight and Balance

Spacecraft weight, balance, and moments of inertia are presented in table 4-1.

4.2 Launch-Escape Subsystem

The launch-escape subsystem (LES) consists of three live motors (launch escape, pitch control, and tower jettison), nozzle skirt, spacecraft escape tower with separation mechanism, and instrumentation sensors and wiring. The alternate mode of tower jettison (i.e. firing the launch-escape and pitch-control motors) will be used on the BP-15 spacecraft. (See fig. 4-1.) There will not be an igniter in the tower-jettison motor. Mounted within the nose cone is a Q-ball. (See fig. 4-2.)

4.2.1 Q-ball.- See reference 3. Figure 4-2 shows the Q-ball assembly.

4.2.2 Ballast enclosures.- The ballast enclosure forms the structure between the Q-ball and the pitch-control-motor support structure. It has a truncated-cone shape and provides an enclosure for sheet-led ballast which is attached to the pitch-control-motor support structure. Figure 4-3 illustrates the ballast enclosure.

4.2.3 Pitch-control motor.- The pitch-control motor is a live, solid-propellant motor providing a thrust of 2,800 pounds for a duration of 0.5 second. It is 9 inches in diameter, 22 inches in length, and weighs about 47 pounds. The housing for the motor forms the structure between the ballast enclosure and the tower-jettison motor. Figure 4-3 illustrates the pitch-control-motor housing.

4.2.4 Tower-jettison motor.- The tower-jettison motor will consist of an actual grain motor configuration, but will not have igniters installed.

4.2.5 Launch-escape motor.- The launch-escape motor is a solid-fuel motor 26 inches in diameter, 185 inches in length, and weighs approximately 4,767 pounds. Four fixed exhaust nozzles are canted to minimize impingement of jet blast on the command module (CM). The resultant thrust vector is alined $2.5^\circ \pm 0.5^\circ$ from the motor centerline. Nominal thrust is 155,000 pounds at 36,000-foot altitude and 70° F with burnout occurring in approximately 8 seconds.

4.2.6 Launch-escape tower.- See reference 3.

4.2.7 Tower release mechanism.- See reference 3.

4.2.8 Tower sequencer.- Dual sequencer units (channels A and B) are provided for the LES and are located on the tower structure. Each unit consists of one motor switch. An output voltage from the mission sequencer (located in the command module) drives each motor switch to the ARM position. The switches then allow electrical power from the pyrotechnic bus to be applied to the tower separation subsystem explosive bolts and the launch-escape motor and pitch-control motor ignition squibs. Figure 4-4 illustrates the tower-sequencer locations.

4.2.9 Tower separation subsystem.- The LES on boilerplate 15 provides for automatic tower separation and jettison, using the launch-escape and pitch-control motors. Tower jettison will be initiated 10 seconds after S-IV ignition by a signal from the instrument unit (IU) to the mission sequencer. The mission sequencer in turn energizes the dual tower sequencer motor switches, which allow electrical power from the pyrotechnic batteries to energize the tower-separation subsystem explosive bolts and the launch-escape and pitch-control motor-ignition squibs. The tower assembly is separated and propelled clear of the vehicle trajectory by the launch-escape and pitch-control motors.

4.3 Command Module

See reference 3 for description. A sketch of the command module is shown in figure 4-5.

4.3.1 Crew compartment.- See reference 3.

4.3.2 Aft heat shield.- See reference 3.

4.3.3 Forward compartment cover.- See reference 3.

4.3.4 Communications and instrumentation subsystem.- See reference 3.

4.3.5 Environmental-control subsystem.- See reference 3.

4.4 Service Module, Plus Insert and Command Module/Service Module Fairing

The boilerplate service module (SM) is a cylindrical aluminum structure 15¹/₂ inches in diameter and 14¹/₂ inches in length. An exterior nonstructural fairing, 10.75 inches long, between the command module and the service module houses a non-functioning separation mechanism, support structure for distribution of basic loads imposed by the command module on the service module, and fixed umbilical connections between the two

modules. Figure 4-6 illustrates the interface attachment between the command module and service module. The attachment design shown is typical in 6 places. The length of the service module, including the command module/service module fairing, is 152 inches. The length of the boilerplate service module is extended to simulate airframe configuration by an aluminum insert, 52 inches long, which is attached to the adapter. The total length of the service module, the command module/ service module fairings, and the insert is 204 inches. The service module contains, in addition to the fixed umbilical, instrumentation sensors, dummy reaction-control subsystem (RCS) nozzles to simulate external configuration, four flush-mounted C-Band antennas, and an umbilical fitting for external electrical and fluid lines. Total weight of the service module is approximately 4,167 pounds. Figure 4-7 illustrates the service module and adapter.

4.5 Spacecraft Adapter

The adapter is a cylindrical aluminum structure attached to the instrument unit with bolts. The adapter is 154 inches in diameter and 92 inches in length. Within the adapter are measurement sensors and Apollo-Saturn interface wiring. No inflight separation from the service module or the instrument unit is required. Total weight is approximately 3,604 pounds, including the insert and ballast. A panel which acts as an air barrier is mated between the adapter and the Saturn I instrument unit.

4.6 Instrument Unit

The instrument unit of the Saturn I is a cylindrical section attached to the forward end of the S-IV stage containing the guidance and control subsystem, flight sequencers, telemetry system, tracking system, electrical power subsystem, and emergency detection subsystem logic circuitry.

4.7 Launch Vehicle

The launch vehicle for boilerplate 15 is a Saturn I, designated SA-7, and consists of a first stage (S-I), second stage (S-IV), and an instrument unit. The S-I generates a nominal sea-level thrust of 1,500,000 pounds using eight Rocketdyne H-1 engines burning liquid oxygen (LOX) and kerosene (RP-1). The S-IV generates a nominal vacuum thrust of 90,000 pounds using six Pratt & Whitney RL-10-43 engines burning LOX and liquid hydrogen (LH₂).

TABLE 4-1.-SPACESHIP WEIGHT AND BALANCE

Item	Total weight, lb	Center of gravity, in.			Moments of inertia, slug-ft ²		
		X _a	Y _a	Z _a	I _x (Roll)	I _y (Pitch)	I _z (Yaw)
Launch-escape subsystem	*6,597	1,293.7	0	-0.2	255	9,260	9,262
Command module	9,463	1,041.4	2.6	5.1	5,660	4,089	4,036
Service module	4,167	950.9	0.9	0.3	4,980	4,173	4,132
Adapter & insert	3,604	785.3	-2.9	-1.4	4,474	4,018	3,965
Total lift-off payload	23,831	1,056.7	0.7	1.8	15,426	169,403	169,237
Minus launch-escape subsystem	6,597	1,293.7	0.0	-0.2	255	9,260	9,262
Total in-orbit payload	17,234	966.0	1.0	2.6	15,161	49,522	49,361

*Calculated LES data are shown; other weights obtained by weighing.

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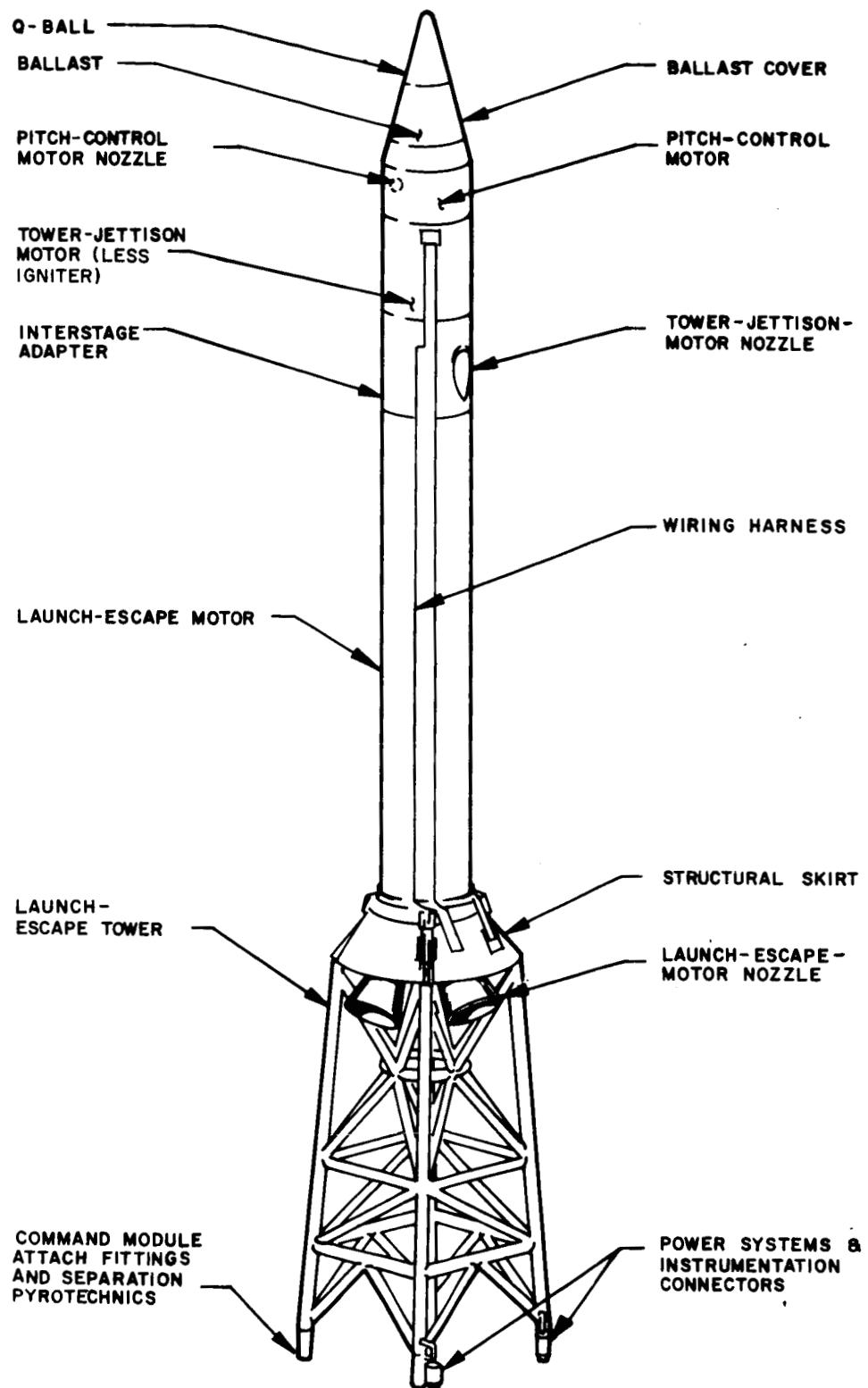


Figure 4-1.-Launch-escape subsystem assembly.

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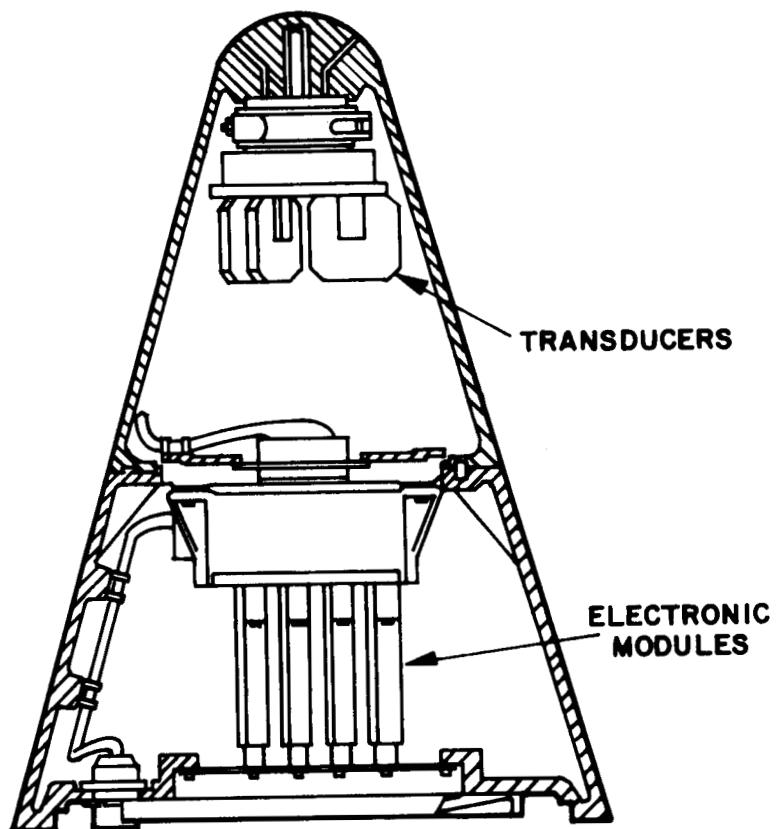


Figure 4-2.- Q-ball assembly.

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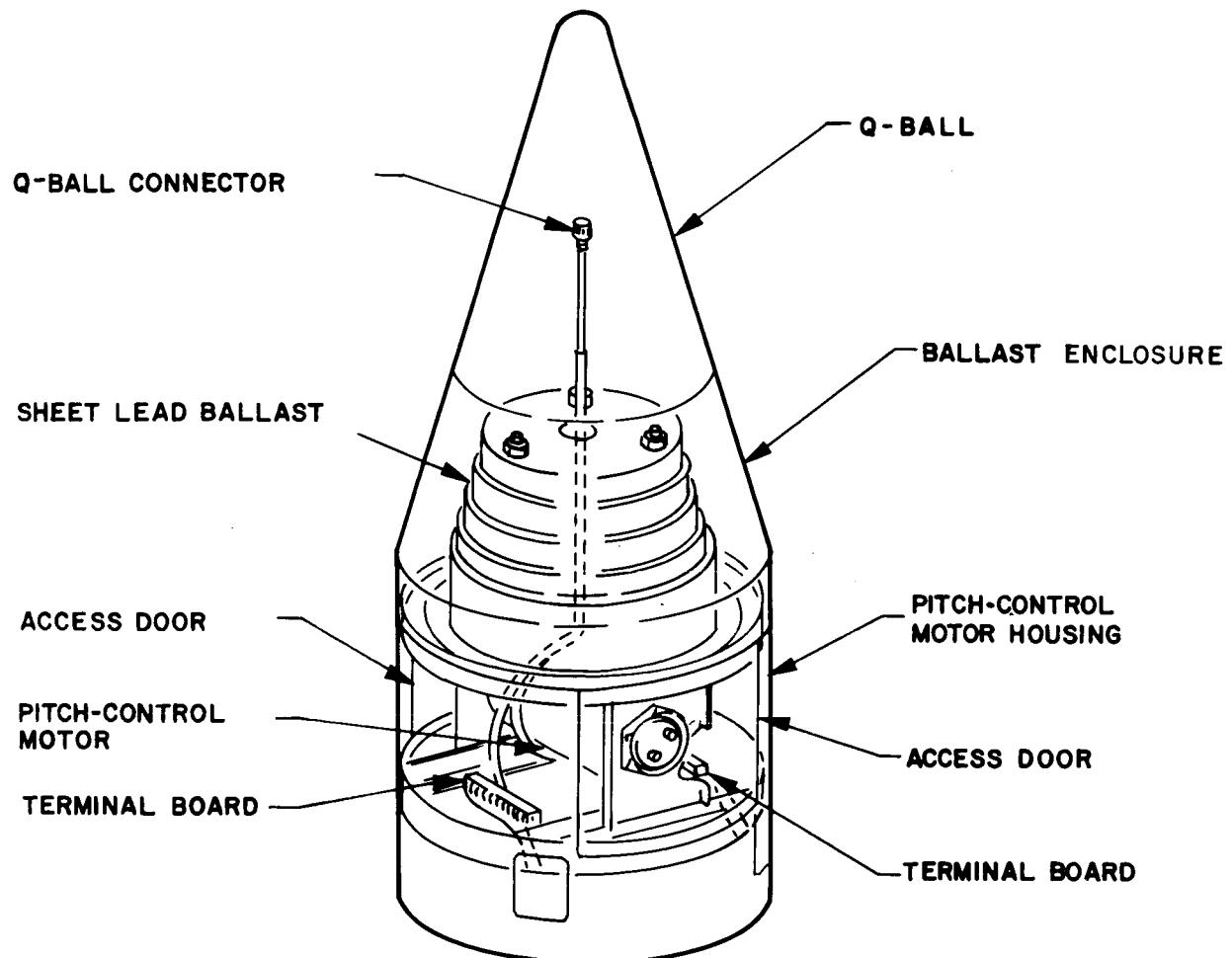


Figure 4-3.- Pitch-control motor housing.

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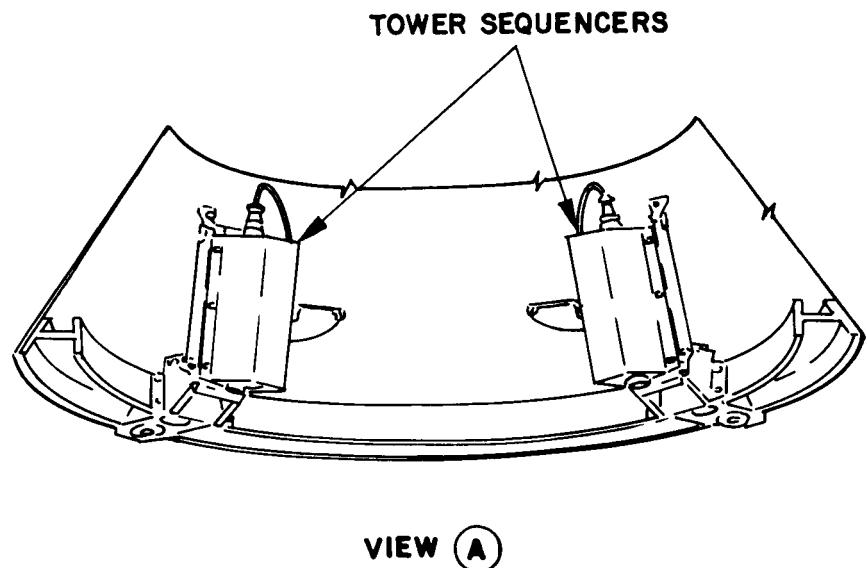
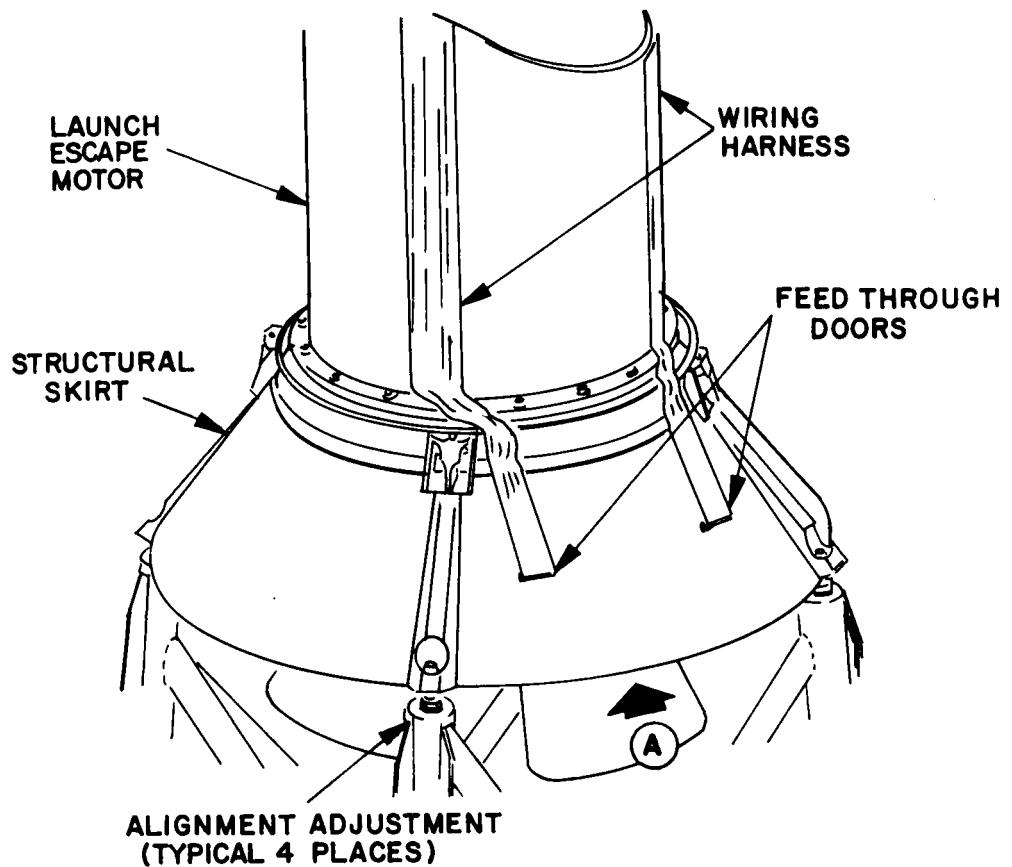


Figure 4-4.-Launch-escape motor and structural skirt area.

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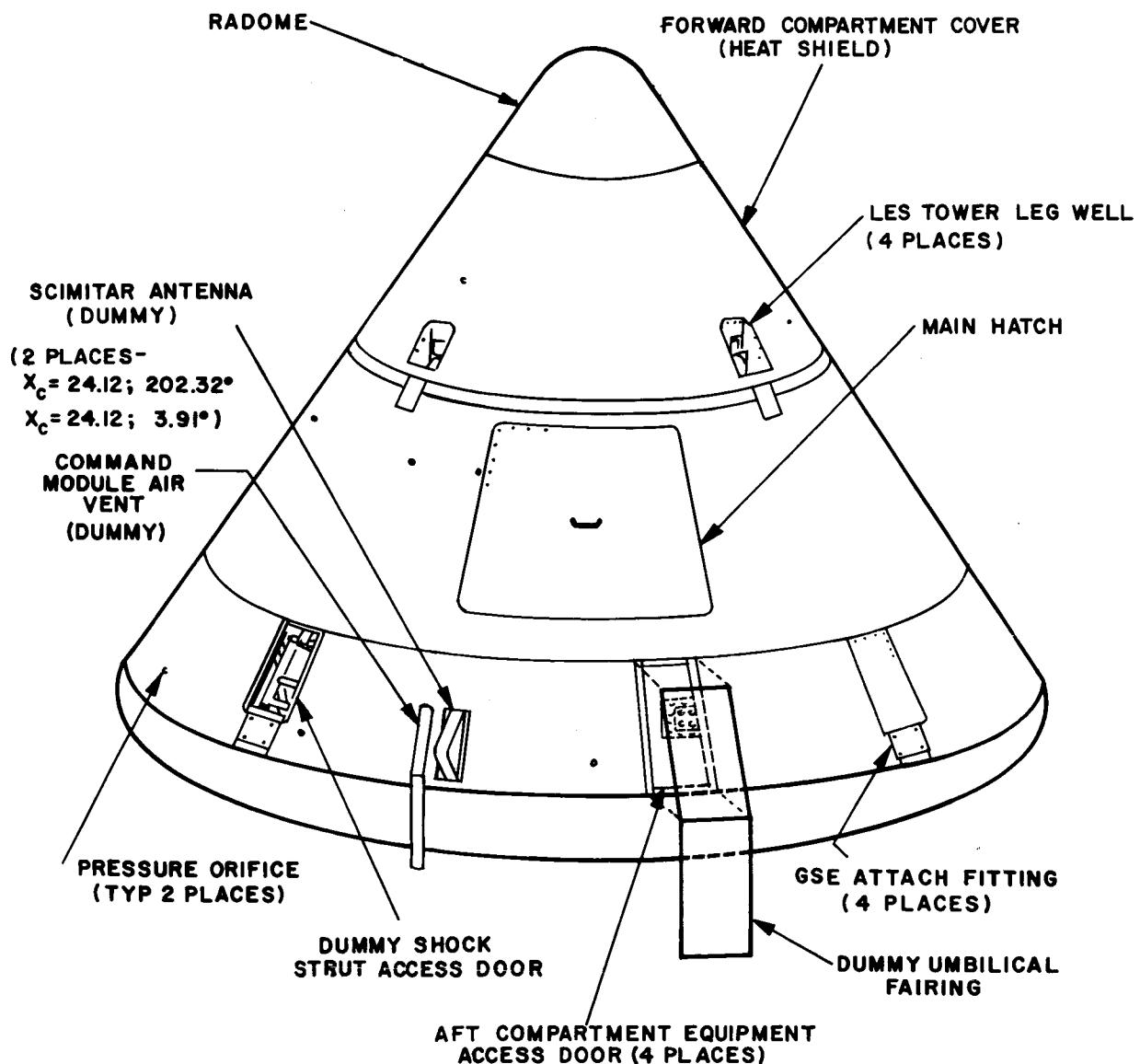


Figure 4-5.-Command module.

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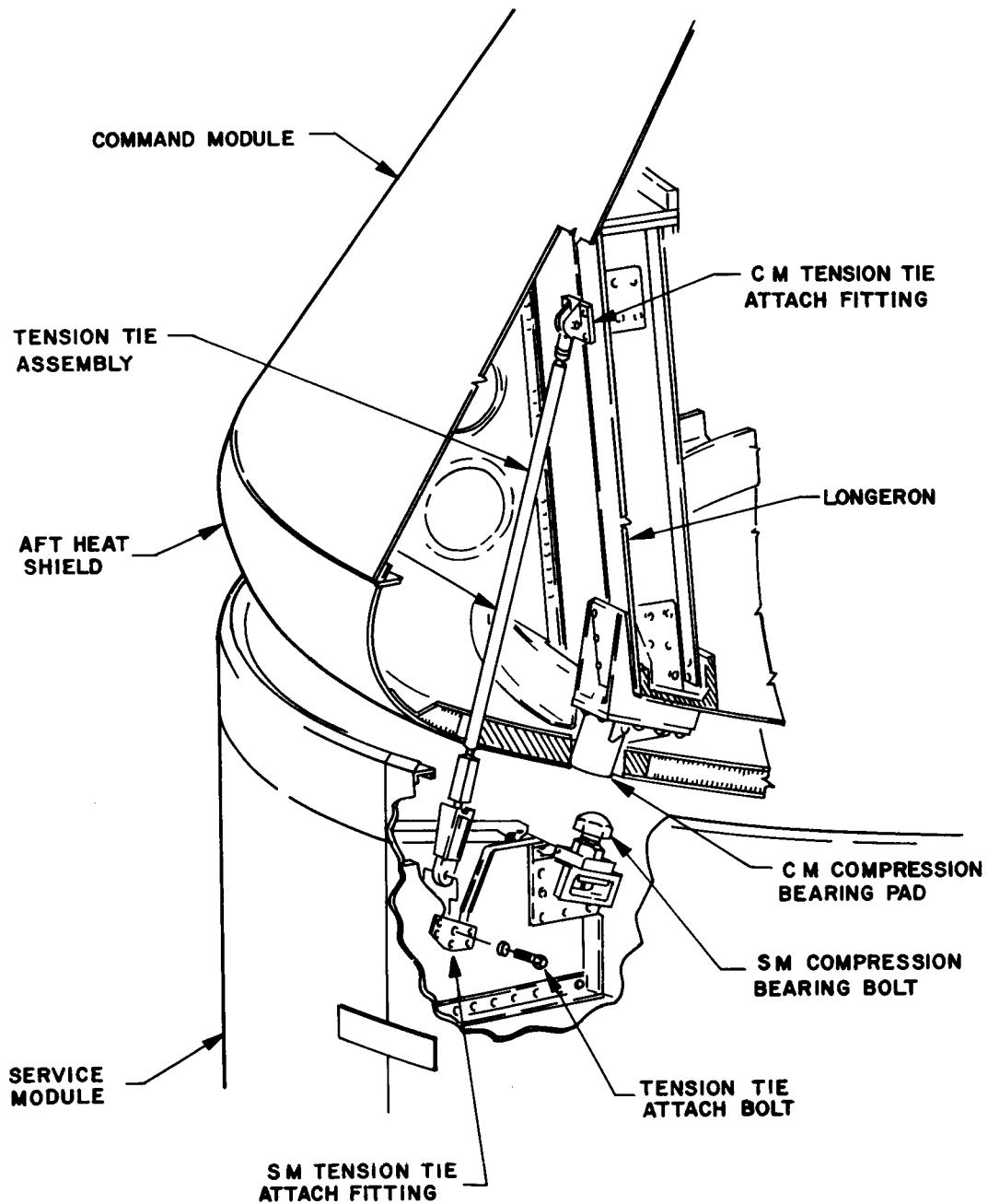


Figure 4-6-Interface attachment between command module and service module.

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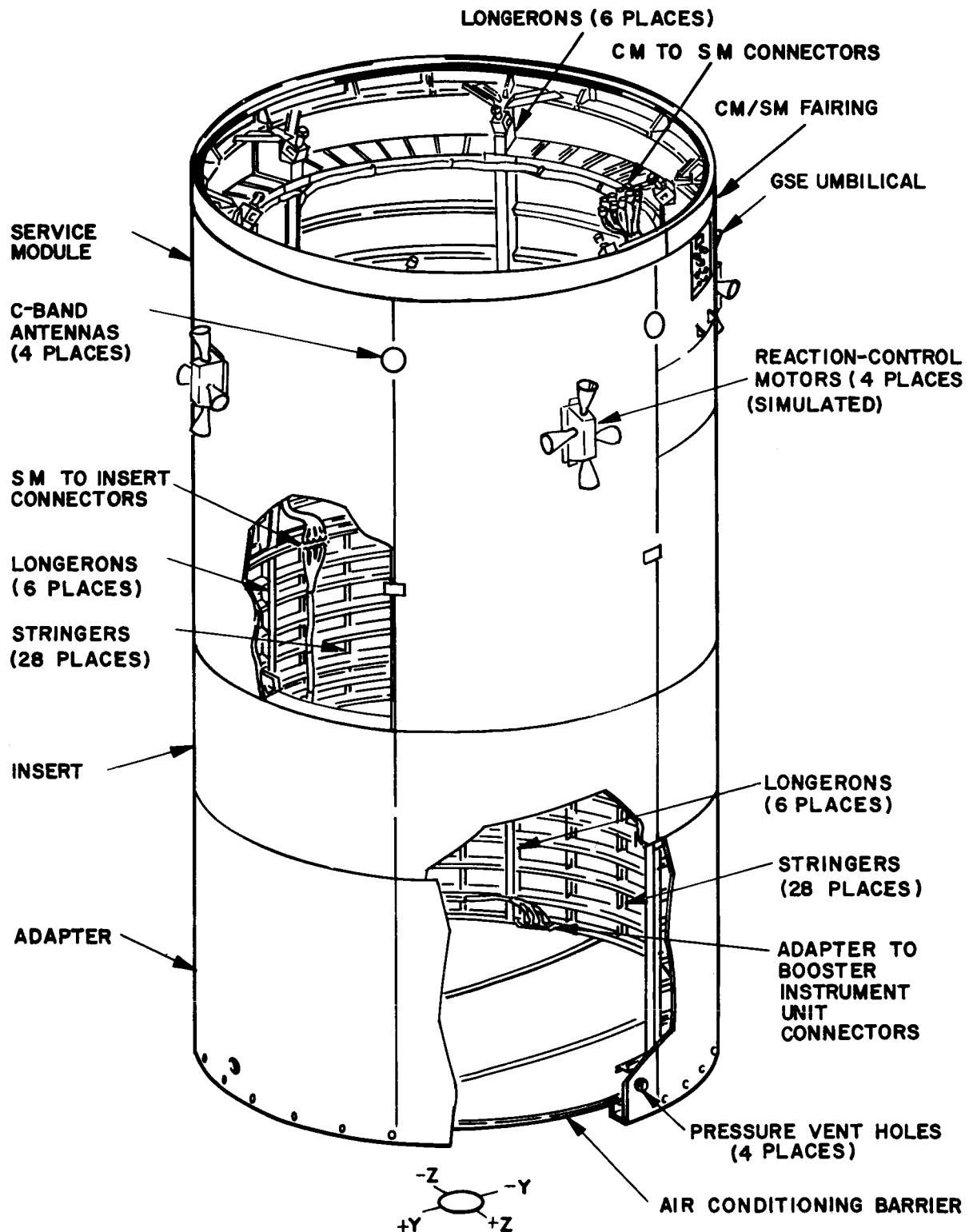


Figure 4-7 -Service module with insert and adapter.

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5.0 STRUCTURAL DESIGN CRITERIA

General

Details of the structural design criteria are available in the NAA document "Apollo Spacecraft Requirements Specifications," SID 62-700-2. (Ref. 4)

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6.0 AERODYNAMIC STABILITY

See reference 3.

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7.0 INSTRUMENTATION REQUIREMENTS

7.1 General

The 133 measurements on the payload can be categorized as follows:

Measurement	Number and location					Total	
	Tower	Command module	Service module	Adapter	Booster	CT	COM
Acceleration	2-CT	3-CT	2-CT				7
Acoustical			1-CT				1
Current	1-COM						1
Discrete events	2-COM	1-COM			1-CT	1	3
Pressure		10-COM	13-CT 1-COM			13	11
Heat flux		12-COM	7-COM	1-COM			20
Strain			2-CT	4-CT			6
Temperature	8-COM	19-COM	24-COM	1-COM			52
Vibration		1-CT	5-CT	2-CT			8
Voltage		10-COM					10
					Total	36 CT	97 COM

Legend: CT - Continuous
COM - Commutated

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7.2 Onboard Instrumentation

This section defines the onboard instrumentation and contains a list of measurements to be made for the evaluation of the flight (table 7-1). This list of measurements is presented for the convenience of the reader, and will not be revised. For revised information see reference 5. Figure 7-1 is a block diagram of the instrumentation and communications system. Figures 7-2(a) to 7-2(f) depict the various measurement locations. The telemetry measurement list for the spacecraft is included in table 7-1, which lists all measurements by channel assignment and by system. The umbilical requirements are presented in table 7-2.

7.3 Data Acquisition Subsystem

Three FM/FM telemetry subsystems operating in the VHF band between 216 and 260 megacycles are used to transmit data acquired onboard the spacecraft. Each telemetry subsystem consists of a subcarrier oscillator (SCO) package and transmitter unit. One of the three subsystems, Telemetry A, will include a 90-channel by 10-samples-per-second commutation plus 11 continuous channels. The second subsystem, Telemetry B, will have 11 continuous channels and a 90-channel by 1.25-sample-per-second commutator. The third subsystem, Telemetry C, will have 12 continuous channels. The transmitter frequencies are as follows: Telemetry A - 237.8 mc, Telemetry B - 247.3 mc, Telemetry C - 257.3 mc.

7.3.1 Signal conditioner package. - One signal conditioner package is required. It is used to adapt all signals received from the measurement transducers to the telemetry signal inputs and to direct the conditioned signal to the respective telemetry. All Range (R) and Zero (Z) calibration and control circuitry is included in the signal conditioner package: Z (Zero) = 15 percent of full-scale (0 to 5 volts) signal; R (Range) = 85 percent of full-scale (0 to 5 volts) signal.

7.3.2 C-band transponder. - Two C-band transponders are required to permit accurate orbital tracking and metric-data generation by ground tracking stations. The transponders are installed in the command module. The operating characteristics of the transponder are as follows:

Receive:

Frequency, mc	5690
Pulse code, pulses	2
Pulse spacing, μ seconds	3.5
Pulse width, μ seconds	1.0

Transmit:

Frequency, mc	5765
Time Delay, μ seconds	2.0
Pulse width, μ seconds	0.75

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7.3.3 Telemetry antenna.- The telemetry antenna subsystem consists of a multiplexer, filter and a VHF omniantenna. The VHF omniantenna is located under a radome in the nose of the forward heat shield of the CM.

7.3.4 C-band antenna.- The C-band antenna subsystem will be used to receive interrogation pulses and to transmit the transponder reply. The C-band antenna subsystem will consist of four flush-mounted circular-polarized antennas and two power dividers. Each C-band transponder will utilize one power divider and two antennas. The antennas will be located 90° apart around the upper portion of the service module at station X_a = 954.08.

7.4 Measurement Requirement List Nomenclature

The measurement requirement list consists of all flight measurement parameters, and these parameters are grouped by functional spacecraft subsystems to aid in performance evaluation. The format and nomenclature are briefly described as follows:

7.4.1 Measurement identification.- The measurement identification (Meas. ID) number consists of seven characters (letters and numbers). The first letter designates the measurement location by module.

A	Adapter
B	Booster (launch vehicle)
C	Command module
L	Launch-escape tower
S	Service module

The second letter denotes the subsystem within which the measurement originates.

A	Structures
C	Electrical
D	Launch-escape
E	Earth landing
F	Environmental control
G	Guidance and navigation
H	Stabilization and control
J	Life subsystems
K	Flight technology
L	Inflight test
P	Propulsion
R	Reaction control
S	Crew safety
T	Communications and instrumentation

The numerical characters 3 to 6 are normally assigned sequentially per measurement and serve only to identify each measurement. The seventh character denotes the type of measurement.

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A	Acceleration	M	Mass
B	Phase	P	Pressure
C	Current	Q	Quantity
D	Vibration	R	Rate
E	Power	S	Strain
F	Frequency	T	Temperature
G	Force	V	Voltage
H	Position	W	Time
J	Biomedical	X	Discrete event
K	Radiation	Y	Acoustical
L	Velocity	Z	pH acidity

7.4.2 Measurement description.- The measurement description is a brief, definitive title given to each measurement. Standard abbreviations are used, where applicable, to keep the measurement description length within 32 characters, including spaces.

7.4.3 Telemetry channel.-

(a) Link (LK). LK designates the telemetry package or the rf carrier as package A, package B, or package C.

(b) Subcarrier Number (SC No.). SC No. designates the telemetry commutator segment assigned to the measurement for that vehicle, in terms of channels 1-18.

(c) Commutator Segment (COM SEG). COM SEG designates the telemetry commutator segment assigned to the measurement for that vehicle.

7.4.4 Data range.- The data range denotes the minimum and maximum values for a parameter in engineering units.

7.4.5 Response rate.- The response rate denotes the rate and unit required to provide satisfactory data resolution to time or wave form. Response for continuous data monitoring (telemetry or recorder) will be specified in cycles per second (cps), and sampled-data monitoring will be specified in samples per second (S/S).

7.4.6 Location.- The location coordinate denotes the physical location within the spacecraft where the measurement is taken. When the location is given in polar coordinates, it is referenced from the +Z axis (+Z = 0°). The angle increases as the measurement location changes progressively from the +Z axis to the +Y axis. Figure 7-3 illustrates the axis system used for the Apollo spacecraft.

7.5 Electrical Umbilical Functions

The electrical umbilical functions required for boilerplate 15 are listed in table 7-2. These functions will be routed through the service module umbilical or the adapter/Saturn IU interface umbilical and will be used for checkout and monitoring of the spacecraft during testing.

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7.6 Changes

Information in tables 7-1 and 7-2 is subject to change without a revision of the Mission Directive.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST

Meas. ID	Measurement Description	(a) STRUCTURES SYSTEM						Location	
		Channel	L SC COM X NO SEG	Data Range Low	Data Range High	Response Unit	Response Rate		
C A0001 A	X AXIS HIGH	C-	8	-2	+10	G	0-30	CPS	XC78, YCO, ZC21
S A0003 A	Z AXIS SPACECRAFT ACCEL	C-T	-0.5	+0.5	G	0-20	CPS	XA866, YAO, ZA73	
S A0004 A	Y AXIS SPACECRAFT ACCEL	A-6	-0.5	+0.5	G	0-20	CPS	XA866, YAO, ZA73	
C A0005 A	Y AXIS SPACECRAFT ACCEL	C-6	-0.5	+0.5	G	0-20	CPS	XC78, YCO, ZC21	
C A0007 A	Z AXIS SPACECRAFT ACCEL	B-6	-0.5	+0.5	G	0-20	CPS	XC78, YCO, ZC21	
L A0011 A	Y AXIS TOWER ACCEL	B-7	-2	+2	G	0-30	CPS	XL380, YLO, ZL6	
L A0012 A	Z AXIS TOWER ACCEL	T-8	-2	+2	G	0-30	CPS	XL380, YL6, ZLO	
C A0021 D	CM RADIAL VIBRATION 1	A-16	-50	+50	G	20-1000	CPS	XC14, YC40.4,ZC37.3	
C A0071 P	CONICAL SURFACE PRESSURE 1	A-E-66	+0	+15	PSIA	10	S/S	XC76, 357 DEG	
C A0072 P	CONICAL SURFACE PRESSURE 2	A-E-67	+0	+15	PSIA	10	S/S	XC76, 87 DEG	
C A0073 P	CONICAL SURFACE PRESSURE 3	A-E-68	+0	+15	PSIA	10	S/S	XC36, 357 DEG	
C A0074 P	CONICAL SURFACE PRESSURE 4	A-E-69	+0	+15	PSIA	10	S/S	XC36, 93 DEG	
C A0075 P	CONICAL SURFACE PRESSURE 5	A-E-70	+0	+15	PSIA	10	S/S	XC26, 180 DEG	

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

Meas. ID	Measurement Description	STRUCTURES SYSTEM (Cont.)						Location
		Channel L SC COM K NO SEG	Channel SC COM K NO SEG	Data Range Low	Data Range High	Response Rate	Response Unit	
C A0076 P	CONICAL SURFACE PRESSURE 6	A-E-71	+0	+15	PSIA	10	S/S	XG27, 357 DEG
C A0077 P	CONICAL SURFACE PRESSURE 7	A-E-72	+0	+15	PSIA	10	S/S	XG27, 87 DEG
C A0078 P	CONICAL SURFACE PRESSURE 8	A-E-73	+0	+15	PSIA	10	S/S	XG20, 357 DEG
C A0079 P	CONICAL SURFACE PRESSURE 9	A-E-74	+0	+15	PSIA	10	S/S	XG20, 180 DEG
S A0086 D	SM RADIAL VIBRATION 2	C-18	-50	+50	G	20-1000	CPS	XA965.2, YA42.8, ZA-58
S A0087 D	SM RADIAL VIBRATION 3	C-17	-50	+50	G	20-1000	CPS	XA953, YA-53.9, ZA47.7
S A0088 D	SM RADIAL VIBRATION 4	B-17	-50	+50	G	20-1000	CPS	XA940.4, YA68.3, ZA22.8
A A0089 D	ADAPTER RADIAL VIBRATION 5	LV TM	-50	+50	G	25-2000	CPS	XA777.7, YA0, ZA72
A A0090 D	ADAPTER RADIAL VIBRATION 6	LV TM	-50	+50	G	25-2000	CPS	XA777.7, YA-15.5, ZA-71
*S A0162 P	FLUCTUATING PRESSURE 3	A-15	+0	+15	PSIA	300	CPS	XAL000, 329.25 DEG
*S A0163 P	FLUCTUATING PRESSURE 4	A-14	+0	+15	PSIA	300	CPS	XA959, 24.1 DEG
*S A0164 P	FLUCTUATING PRESSURE 5	A-14	+0	+15	PSIA	300	CPS	XA959, 58.9 DEG
*S A0165 P	FLUCTUATING PRESSURE 6	B-14	+0	+15	PSIA	300	CPS	XA973, 277.5 DEG
*S A0166 P	FLUCTUATING PRESSURE 7	C-13	+0	+15	PSIA	300	CPS	XA959. 215.3 DEG.

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

Meas. ID	Measurement Description	(a) STRUCTURES SYSTEM (Cont.)				Response Unit	Location
		Channel L SC COM K NO SEG	Data Range Low	Data Range High	Unit		
*S A0167 P	FLUCTUATING PRESSURE 8	C-15	+0	+15	PSIA	300	CPS XA938, 147.9 DEG
*S A0168 P	FLUCTUATING PRESSURE 9	B-12	+0	+15	PSIA	300	CPS XA932, 187.25 DEG
*S A0169	FLUCTUATING PRESSURE 10	A-11	+0	+15	PSIA	300	CPS XA919, 58.9 DEG
*S A0170 P	FLUCTUATING PRESSURE 11	A-12	+0	+15	PSIA	300	CPS XA893.5, 316.6 DEG
*S A0171 P	FLUCTUATING PRESSURE 12	A-13	+0	+15	PSIA	300	CPS XA906, 277.25 DEG
*S A0172 P	FLUCTUATING PRESSURE 13	C-11	+0	+15	PSIA	300	CPS XA881, 277.25 DEG
*S A0173 P	FLUCTUATING PRESSURE 14	C-12	+0	+15	PSIA	300	CPS XA764, 183 DEG
*S A0174 P	FLUCTUATING PRESSURE 15	B-11	+0	+15	PSIA	300	CPS XA737, 3 DEG
*A A0195 S	STRAIN 1 ADAPTER	A- 9	-500	+500	UI/IN	100	CPS XA736, YA0, ZAO
*A A0196 S	STRAIN 2 ADAPTER	A-10	-500	+500	UI/IN	100	CPS XA736, YAO, ZA-76
*A A0197 S	STRAIN 3 ADAPTER	B-10	-500	+500	UI/IN	100	CPS XA736, YA-76, ZAO
*A A0198 S	STRAIN 4 ADAPTER	C-10	-500	+500	UI/IN	100	CPS XA736, YAO, ZA76
S A0550 R	HEAT FLUX (CALORIMETER)	17	B-13-28	+0	+5 B/F/S	1.25	S/S XS338, 183 DEG
S A0551 R	HEAT FLUX (CALORIMETER)	18	B-13-29	+0	+5 B/F/S	1.25	S/S XS315, 187.2 DEG

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

(a) STRUCTURES SYSTEM (Cont.)

Meas. ID	Measurement Description	Channel		Data Range		Response		Location
		L	SC COM K NO SEG	Low	High	Unit	Rate	
S A0552 R	HEAT FLUX (CALORIMETER)	20	B-13-31	+0	+5	B/F/S	1.25	S/S
S A0553 R	HEAT FLUX (CALORIMETER)	13	B-13-24	+0	+5	B/F/S	1.25	S/S
S A0554 R	HEAT FLUX (CALORIMETER)	14	B-13-25	+0	+5	B/F/S	1.25	S/S
S A0555 R	HEAT FLUX (CALORIMETER)	16	B-13-27	+0	+5	B/F/S	1.25	S/S
S A0560 T	CALORIMETER BODY TEMP	17	B-13-48	+0	+300	DEG C	1.25	S/S
S A0561 T	CALORIMETER BODY TEMP	18	B-13-49	+0	+300	DEG C	1.25	S/S
S A0562 T	CALORIMETER BODY TEMP	20	B-13-51	+0	+300	DEG C	1.25	S/S
S A0563 T	CALORIMETER BODY TEMP	13	B-13-44	+0	+300	DEG C	1.25	S/S
S A0564 T	CALORIMETER BODY TEMP	14	B-13-45	+0	+300	DEG C	1.25	S/S
S A0565 T	CALORIMETER BODY TEMP	16	B-13-47	+0	+300	DEG C	1.25	S/S
C A0580 R	HEAT FLUX (CALORIMETER)	1	B-13-12	+0	+25	B/F/S	1.25	S/S
C A0581 R	HEAT FLUX (CALORIMETER)	2	B-13-13	+0	+25	B/F/S	1.25	S/S
C A0582 R	HEAT FLUX (CALORIMETER)	3	B-13-14	+0	+25	B/F/S	1.25	S/S
C A0583 R	HEAT FLUX (CALORIMETER)	4	B-13-15	+0	+25	B/F/S	1.25	S/S

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

(a) STRUCTURES SYSTEM (Cont.)									
Meas. ID	Measurement Description	Channel L SC COM K NO SEG	Data Range Lo. High	Unit	Response Rate	Response Unit	Location		
C A0584 R	HEAT FLUX (CALORIMETER) 5	B-13-16	+0	+25	B/F/S	1.25	S/S	XC52, 3 DEG	
C A0585 R	HEAT FLUX (CALORIMETER) 6	B-13-17	+0	+25	B/F/S	1.25	S/S	XC52, 80 DEG	
C A0586 R	HEAT FLUX (CALORIMETER) 7	B-13-18	+0	+25	B/F/S	1.25	S/S	XC52, 85 DEG	
C A0587 R	HEAT FLUX (CALORIMETER) 8	B-13-19	+0	+25	B/F/S	1.25	S/S	XC52, 95 DEG	
C A0588 R	HEAT FLUX (CALORIMETER) 9	B-13-20	+0	+25	B/F/S	1.25	S/S	XC52, 319 DEG	
C A0589 R	HEAT FLUX (CALORIMETER) 10	B-13-21	+0	+25	B/F/S	1.25	S/S	XC42.65, 3 DEG	
C A0590 R	HEAT FLUX (CALORIMETER) 11	B-13-22	+0	+25	B/F/S	1.25	S/S	XC27, 180 DEG	
C A0591 R	HEAT FLUX (CALORIMETER) 12	B-13-23	+0	+25	B/F/S	1.25	S/S	XA770, 319 DEG	
A A0594 R	HEAT FLUX (CALORIMETER) 19	B-13-30	+0	+ 5	B/F/S	1.25	S/S	XA770, 183 DEG	
S A0598 R	HEAT FLUX (CALORIMETER) 15	B-13-26	+0	+ 5	B/F/S	1.25	S/S	XA933, 183 DEG	
*L A0600 T	TOWER TEMPERATURE 1	B-13-52	+0	+150	DEG C	1.25	S/S	XL90, YL12, ZL0	
L A0601 T	TOWER TEMPERATURE 2	B-13-53	+0	+150	DEG C	1.25	S/S	XL61, YL22, ZL0	
L A0602 T	TOWER TEMPERATURE 3	B-13-54	+0	+150	DEG C	1.25	S/S	XL47, YL0, ZL23	
L A0603 T	TOWER TEMPERATURE 4	B-13-55	+0	+150	DEG C	1.25	S/S	XL47, YL24, ZL23	

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

(a) STRUCTURES SYSTEM (Cont.)							
Meas. ID	Measurement Description	Channel L SC COM K NO SEG	Data Range		Response Rate	Location	
			Low	High			
L A0604 T	TOWER TEMPERATURE 5	B-13-56	+0	+150	DEG C	1.25	S/S
*L A0605 T	TOWER TEMPERATURE 6	B-13-57	+0	+150	DEG C	1.25	S/S
L A0606 T	TOWER TEMPERATURE 7	B-13-58	+0	+150	DEG C	1.25	S/S
L A0607 T	TOWER TEMPERATURE 8	B-13-59	+0	+150	DEG C	1.25	S/S
C A0610 T	CM INTERIOR TEMP	B-13-4	+0	+150	DEG C	1.25	S/S
C A0611 P	CM INTERIOR PRESS	A-E-88	+0	+15	PSIA	10	S/S
S A0612 T	SM INTERIOR TEMP	B-13-5	+0	+150	DEG C	1.25	S/S
*S A0613 P	SM INTERIOR PRESS	A-E-87	+0	+15	PSIA	10	S/S
C A0651 T	CALORIMETER BODY TEMP 1	B-13-32	+0	+300	DEG C	1.25	S/S
C A0652 T	CALORIMETER BODY TEMP 2	B-13-33	+0	+300	DEG C	1.25	S/S
C A0653 T	CALORIMETER BODY TEMP 3	B-13-34	+0	+300	DEG C	1.25	S/S
C A0654 T	CALORIMETER BODY TEMP 4	B-13-35	+0	+300	DEG C	1.25	S/S
C A0655 T	CALORIMETER BODY TEMP 5	B-13-36	+0	+300	DEG C	1.25	S/S
C A0656 T	CALORIMETER BODY TEMP 6	B-13-37	+0	+300	DEG C	1.25	S/S

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

Meas. ID	Measurement Description	STRUCTURES SYSTEM (Concluded)						Location
		Channel L SC COM K NO SEG	Data Range Low	Data Range High	Unit	Rate	Response Unit	
C A0657 T	CALORIMETER BODY TEMP 7	B-13-38	+0	+300	DEG C	1.25	S/S	XC52, 85 DEG
C A0658 T	CALORIMETER BODY TEMP 8	B-13-39	+0	+300	DEG C	1.25	S/S	XC52, 95 DEG
C A0659 T	CALORIMETER BODY TEMP 9	B-13-40	+0	+300	DEG C	1.25	S/S	XC52, 319 DEG
C A0660 T	CALORIMETER BODY TEMP 10	B-13-41	+0	+300	DEG C	1.25	S/S	XC27, 3 DEG
C A0661 T	CALORIMETER BODY TEMP 11	B-13-42	+0	+300	DEG C	1.25	S/S	XC42.65, 3 DEG
C A0662	CALORIMETER BODY TEMP 12	B-13-43	+0	+300	DEG C	1.25	S/S	XC27, 319 DEG
A A0665 T	CALORIMETER BODY TEMP 19	B-13-50	+0	+300	DEG C	1.25	S/S	XAT70, 183 DEG
S A0669 T	CALORIMETER BODY TEMP 15	B-13-46	+0	+300	DEG C	1.25	S/S	XA933, 183 DEG
*S A2120 S	STRAIN 1 SERVICE MODULE	C-16	-500	+500	UI/IN	250	CPS	XA940.4, 62.25 DEG
*S A2121 S	STRAIN 2 SERVICE MODULE	B-16	-500	+500	UI/IN	250	CPS	XA940.4, 77.25 DEG
S A2760 Y	SERVICE MODULE ACOUSTIC	LV TM	+150	+170	DB	25-3000	CPS	XS339, 0 DEG

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont..)

(b) REACTION-CONTROL SYSTEM							
Meas. ID	Measurement Description	Channel L SC COM K NO SEG	Data Range Low High Unit	Response Rate	Response Unit	Location	
*S R7125 T	TEMP INJECTOR HEAD PLUS P ENG SYS A	A-13-67	+32 +392 DEG F	1.25	S/S	XS299, 187.3 DEG	
*S R7134 T	TEMP INJECTOR HEAD CCW ENG SYS A	A-13-68	+32 +392 DEG F	1.25	S/S	XS294, 185 DEG	
*S R7125 T	TEMP INJECTOR HEAD MINUS P ENG SYS A	A-13-69	+32 +392 DEG F	1.25	S/S	XS289, 187.25 DEG	
*S R7160 T	PLUS P ENG HOUSING TEMP SYS A (IN)	A-13-71	+32 +707 DEG F	1.25	S/S	XS300, 187.5	
*S R7161 T	CCW ENG HOUSING TEMP SYS A (IN)	A-13-72	+32 +707 DEG F	1.25	S/S	XS292, 185 DEG	
*S R7162 T	MINUS P ENG HOUSING TEMP SYS A (IN)	A-13-73	+32 +707 DEG F	1.25	S/S	XS288, 187 DEG	
*S R7121 T	TEMP PLUS P ENGINE FLANGE SYS A	A-13-74	+32 +1472 DEG F	1.25	S/S	XS301, 187 DEG	
*S R7123 T	TEMP CCW ENGINE FLANGE SYS A	A-13-75	+32 +1472 DEG F	1.25	S/S	XS290, 185 DEG	
*S R7122 T	TEMP MINUS P ENGINE FLANGE SYS A	A-13-76	+32 +1472 DEG F	1.25	S/S	XS287, 187.4 DEG	
*S R5065 T	TEMP ENGINE PACKAGE A1	A-13-70	+32 +302 DEG F	1.25	S/S	XS294, 187.25 DEG	

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

(b) REACTION-CONTROL SYSTEM (Concluded)									
Meas. ID	Measurement Description	Channel L SC COM K NO SEG	Data Range			Response Rate		Location	
			Low	High	Unit	Rate	Unit		
*S R5876 T	TEMP A ENGINE NOZZLE WALL 1 PLUS P	A-13-77	+32	+2012DEG F	1.25	S/S		XS303,	187.25 DEG
*S R5877 T	TEMP A ENGINE NOZZLE WALL 2 PLUS P	A-13-78	+32	+2012DEG F	1.25	S/S		XS310,	187.25 DEG
*S R5678 T	TEMP A CCW ROLL ENGINE WALL 1	A-13-79	+32	+2012DEG F	1.25	S/S		XS294,	183 DEG
*S R5879 T	TEMP A CCW ROLL ENGINE WALL 2	A-13-80	+32	+2012DEG F	1.25	S/S		XS294,	180 DEG
*S R7183 T	TEMP OUT SURF A ENGINE PACKAGE	A-13-81	+32	+707 DEG F	1.25	S/S		XS294,	187.25 DEG
*S R7175 T	TEMP A ENGINE NOZZLE WALL MINUS P	A-13-82	+32	+2012DEG F	1.25	S/S		XS278,	187.25 DEG
*S A0091 D	A CCW NOZZLE X AXIS VIBRATION	B-18	-200	+200 G	10-500	CPS		XS294,	191 DEG
*S A0092 D	A CCW NOZZLE PARALLEL VIBRATION	B-15	-200	+200 G	10-500	CPS		XS294,	191 DEG

*Measurements different than BP-13.

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

Meas. ID	Measurement Description	(c) ELECTRICAL SYSTEM		Response Rate	Unit	Location		
		Channel L SC COM K NO SEG	Data Range Low [High] Unit					
C C0001 V	DC VOLTAGE MAIN BUS A	A-E-24	+22	+32	VDC	10	S/S	PWR CONTROL BOX
C C0002 V	DC VOLTAGE MAIN BUS B	A-E-25	+22	+32	VDC	10	S/S	PWR CONTROL BOX
C C0003 V	DC VOLTAGE LOGIC BUS A	A-E-22	+ 0	+36	VDC	10	S/S	LES SEQUENCER
C C0004 V	DC VOLTAGE LOGIC BUS B	A-E-23	+ 0	+36	VDC	10	S/S	LES SEQUENCER
C C0005 C	TOTAL DC CURRENT	A-E-25	+ 0	+50	AMPS	10	S/S	PWR CONTROL BOX

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

(d) LAUNCH-ESCAPE SYSTEM							
Meas. ID	Measurement Description	Channel		Data Range Low	Data Range High	Response Unit	Location
		L SC COM	K NO SEG				
B D0001 X	S-I LIFT OFF SIGNAL	A-9, A-10		STEP	100	CPS	SIG COND BOX
L D0033 X	TWR JETT & SEP RELAY CLOSE	A-E-29		STEP	10	S/S	TWR LES SEQUENCER
L D0034 X	TWR JETT & SEP RELAY CLOSE	A-E-29		STEP	10	S/S	TWR LES SEQUENCER
			B				
C D0039 V	TWR JETT AND SEP COMMAND A	A-E-37	+0	+36	VDC	10	S/S
C D0040 V	TWR JETT AND SEP COMMAND B	A-E-38	+0	+36	VDC	10	S/S
C D0185 V	DC VOLTAGE TWR PYRO BUS A	A-E-28	+0	+36	VDC	10	S/S
C D0186 V	DC VOLTAGE TWR PYRO BUS B	A-E-35	+0	+36	VDC	10	S/S

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

Meas. ID	Measurement Description	COMMUNICATIONS AND INSTRUMENTATION SYSTEM				Response Rate	Unit	Location
		Channel L	SC COM K NO SEG	Data Range Low	Data Range High			
C T0201 T	TM RF XMTR A TEMP	B-13-6	+0	+150	DEG C	1.25	S/S	TM RF XMTR A
C T0202 T	TM RF AMP A TEMP	B-13-7	+0	+150	DEG C	1.25	S/S	TM RF AMP A
C T0203 T	TM RF XMTR B TEMP	B-13-8	+0	+150	DEG C	1.25	S/S	TM RF XMTR B
C T0204 T	TM RF AMP B TEMP	B-13-9	+0	+150	DEG C	1.25	S/S	TM RF AMP B
C T0205 T	TM RF XMTR C TEMP	B-13-10	+0	+150	DEG C	1.25	S/S	TM RF XMTR C
C T0207 T	TM RF AMP C TEMP	B-13-11	+0	+150	DEG C	1.25	S/S	TM RF AMP C
C T0002 V	TRANSPONDER A TRIGGER	A-E-57	+0	+5	VDC	10	S/S	TRANSPONDER A
C T0003 V	TRANSPONDER B TRIGGER	A-E-58	+0	+5	VDC	10	S/S	TRANSPONDER B
C T0007 X	R AND Z CALIBRATION MONITOR	A-E-59	STEP	10			S/S	SIG. COND. BOX

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TABLE 7-1.-BOILERPLATE 15 MEASUREMENT LIST (Cont.)

(f) ENVIRONMENTAL-CONTROL SYSTEM						
Meas. ID	Measurement Description	Channel L SC COM K NO SEG	Date Range Low High Unit	Response Rate	Unit	Location
C F0400 T	R/D ECS CM INTERIOR TEMP	GSE	+0 +150 DEG F			CM INTERIOR
C F0401 T	R/D ECS COLD PLATE INLET TEMP	GSE	+0 +100 DEG F			COLD PLATE INLET
C F0402 T	R/D ECS COLD PLATE OUTLET TEMP	GSE	+0 +100 DEG F			COLD PLATE OUTLET
C F0403 P	R/D ECS TANK INLET PRESS	GSE	+0 +50 PSID			COOL TANK INLET
C F0404 T	R/D ECS TANK OUTLET TEMP	GSE	+0 +100 DEG F			COOL TANK OUTLET
C F0405 P	R/D ECS PUMP OUTLET PRESS	GSE	+0 + 50 PSID			COOL PUMP OUTLET

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TABLE 7-2 BOTTLERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS

SM to GSE	Function	Voltage range, v d-c	Wire gauge	Origin	Connector and pin
1. Regulated power supply (5 v d-c)	Monitor	0 to 5	16	Signal conditioning box (SCB)	S15J1-56
2. Main battery current total	Monitor	0 to 5	16	Signal conditioner (Sig. Cond.)	S15J1-55
3. Umbilical separation	Monitor	28	20	Umbilical	S15J1-30
4. Umbilical Separation	Monitor	28	20	Umbilical	S15J1-31
5. ECS coldplate inlet temp. (+)	Monitor	0 to 5	20	ECS	S15J1-52
6. ECS coldplate inlet temp. (-)	Return	0 to 5	20	ECS	S15J1-53
7. ECS coldplate outlet temp. (+)	Monitor	0 to 5	20	ECS	S15J1-50
8. ECS coldplate outlet temp. (-)	Return	0 to 5	20	ECS	S15J1-51
9. ECS coolant outlet pressure (+)	Monitor	0 to 5	20	ECS	S15J1-48
10. ECS coolant output pressure (-)	Return	0 to 5	20	ECS	S15J1-49
11. ECS CM air temperature (+)	Monitor	0 to 5	20	ECS	S15J1-46
12. ECS CM air temperature (-)	Return	0 to 5	20	ECS	S15J1-45
13. ECS tank outlet temperature (+)	Monitor	0 to 5	20	ECS	S15J1-32
14. ECS tank outlet temperature (-)	Return	0 to 5	20	ECS	S15J1-41

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TABLE 7-2 BOTTLERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

SM to GSE (Cont.)	Function	Voltage range, v d-c	Wire gage	Origin	Connector and pin
15. ECS inlet pressure (+)	Monitor	0 to 5	20	ECS	S15J1-35
16. ECS inlet pressure (-)	Return	0 to 5	20	ECS	S15J1-36
17. Shield					S15J1-54
18. Shield					S15J1-47
19. Signal common to GSE	Return	0 to 5	16	Sig. Cond.	S15J1-60
20. Signal common to GSE	Return	0 to 5	16	Sig. Cond.	S15J1-59
21. Instrumentation bus control	Holding	28	16	Power-control Box (PCB)	S15J2-28
	Power	28	16	PCB	S15J2-41
22. External power bus A	Power	28	16	PCB	S15J2-42
23. External power bus A	Power	28	16	PCB	S15J2-45
24. External power bus A	Power	28	16	PCB	S15J2-46
25. External power bus A	Power	28	16	PCB	S15J2-58
26. External power bus B	Power	28	16	PCB	S15J2-57
27. External power bus B	Power	28	16	PCB	S15J2-37
28. External power bus B	Power	28	16	PCB	

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TABLE 7-2 BOILERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

SM to GSE (Cont.)	Function	Voltage range, v d-c	Wire gauge	Origin	Connector and pin
29. External power bus B	Power	28	16	PCB	S15J2-38
30. External power ground	Return	28	16	PCB	S15J2-59
31. External power ground	Return	28	16	PCB	S15J2-60
32. External power ground	Return	28	16	PCB	S15J2-47
33. External power ground	Return	28	16	PCB	S15J2-48
34. External power ground	Return	28	16	PCB	S15J2-43
35. External power ground	Return	28	16	PCB	S15J2-44
36. External power ground	Return	28	16	PCB	S15J2-40
37. External power ground	Return	28	16	PCB	S15J2-39
38. Main bus A monitor & regulation(+)	Meter	28	16	PCB	S15J2-35
39. Main bus A monitor & regulation(-)	Meter	28	16	PCB	S15J2-36
40. Main bus B monitor & regulation(+)	Meter	28	16	PCB	S15J2-34
41. Main bus B monitor & regulation(-)	Meter	28	16	PCB	S15J2-33
42. Logic battery A voltage	Meter	28	16	Sequencer	S15J2-23
43. Logic battery B voltage	Meter	28	16	Sequencer	S15J2-19

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TABLE 7-2 BOILERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

SM to GSE (Cont.)	Function	Voltage range, v d-c	Wire gage	Origin	Connector and pin
44. Pyro battery A voltage	Meter	28	20	Sequencer	S15J2-17
45. Pyro battery B voltage	Meter	28	20	Sequencer	S15J2-18
46. Battery A monitor and bleed	Monitor	28	16	PCB	S15J2-56
47. Battery B monitor and bleed	Monitor	28	16	PCB	S15J2-55
48. Bus A power transfer	Monitor	28	16	PCB	S15J2-16
49. Bus B power transfer	Monitor	28	16	PCB	S15J2-15
50. TM A RF Xmtr Control	Holding	28	16	PCB	S15J2-29
51. TM RF power amplifier On (latching relay)	Momentary	28	16	PCB	S15J2-30
52. C-Band transponder #1 control	Holding	28	16	PCB	S15J2-31
53. C-Band transponder #2 control	Holding	28	16	PCB	S15J2-32
54. ECS instrumentation power	Power	28	20	ECS	S15J2-27
55. ECS instrumentation common	Return	28	16	ECS	S15J2-26
56. GSE relay power (+)	Power	28	16	Relay box	S15J2-53
57. GSE relay power (-)	Return	28	16	Relay box	S15J2-54

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TABLE 7-2 BOTTLERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

SM to GSE (Cont.)	Function	Voltage range, v d-c	Wire gage	Origin	Connector and pin
58. Shield	Shield to be used				S15J2-25
59. R calibrate	Momentary	28	20	Junction Box(JB)	S15J3-51
60. Z calibrate	Momentary	28	20		S15J3-52
61. TM B RF Xmtr control	Holding	28	16	JB 2	S15J3-39
62. TM C RF Xmtr control	Holding	28	16	JB 2	S15J3-40
63. TM RF power amplifier-off control (latching relay)	Momentary	28	16	PCB	S15J3-41
64. TM calib. enable control	Holding	28	16	JB2	S15J3-43
65. TM calib. auto-manual control	Holding	28	16	PCB	S15J3-44
66. TM calib. control manual step	Momentary	28	16	JB2	S15J3-45
67. Tower sequencer A & B safe command	Momentary	28	20	Sequencer	S15J3-38
Tower sequencer A & B safe command	Momentary	28	20	Sequencer	S15J3-35
68. Tower sequencer safe command common (-)	Return	28	16	Sequencer	S15J3-59

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TABLE 7-2 BOILERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

SM to GSE (Cont.)	Function	Voltage range, v d-c	Wire gauge	Origin	Connector and pin
Tower sequencer safe command Common (-)	Return	28	16	Sequencer	S15J3-34
69. ECS external control	Holding	28	20	PCB	S15J3-56
70. Voltmeter common (-)	Return	28	16	Sequencer	S15J3-55
71. TM composite video A	Monitor	Video	Coax	Modulation package	S13-P201-1
72. TM composite video B	Monitor	Video	Coax	Modulation package	S13P201-2
73. TM composite video C	Monitor	Video	Coax	Modulation package	S13P201-3
74. TM composite video spare	Spare	Video	Coax	Modulation package	S13P201-4

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TABLE 7-2 BOILERPLATE 15. ELECTRICAL UMBILICAL FUNCTIONS (CONT)

Adapter/Saturn IU interface	Function	Voltage range	Wire gage	Origin	Connector and pin
1. Q-ball heater power (+)	Power	115 v a-c	20	S-I GSE	A15J1-MM
2. Q-ball heater power (-)	Return	115 v a-c	20	S-I GSE	A15J1-PP
3. Q-ball heater power shield terminate	Shield	0 v d-c	20	Q ball	A15J1-MN
4. Q-ball electronic power (+)	Power	28 v d-c	20	IU	A15J1-c
5. Q-ball electronic power common (-)	Return	0 v d-c	20	IU	A15J1-b
6. Q-ball electronic power shield terminate	Shield	0 v d-c	20	Q ball	A15J1-a
7. Q-ball simulate command	Power	28 v d-c	20	S-I GSE	A15J1-e
8. Q-ball surface temp TTM ref (+)	Signal	0 v d-c 0 to 5 v d-c	20	Q ball	A15J1-s
9. Q-ball surface temp TTM ref (-)	Return	0 v d-c	20	IU	A15J1-r
10. Q-ball dynamic pressure TTM (+)	Signal	0 to 5 v d-c	20	IU	A15J1-g
11. Q-ball dynamic pressure TTM Ref(-)	Return	0 v d-c	20	IU	A15J1-f
12. Q-ball alpha-q yaw TTM (+)	Signal	0 to 5 v d-c	20	Q ball	A15J1-i
13. Q ball alpha-q yaw TTM Ref (-)	Return	0 v d-c	20	IU	A15J1-h

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TABLE 7-2 BOILERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

Adapter/Saturn IU Interface (Cont.)	Function	Voltage range, v d-c	Wire gage	Origin	Connector and pin
14. Q-ball alpha-q pitch TLM (+)	Signal	0 to 5	20	Q ball	A15J1-k
15. Q-ball alpha-q pitch TLM Ref (-)	Return	0	20	TU	A15J1-j
16. Q-ball alpha-q yaw output (+)	Signal	0 to 30	20	Q ball	A15J1-n
17. Q-ball alpha-q yaw output (-)	Signal	0 to 30	20	Q ball	A15J1-m
18. Q-ball alpha-q pitch output (+)	Signal	0 to 30	20	Q ball	A15J1-q
19. Q-ball alpha-q pitch output (-)	Signal	0 to 30	20	Q ball	A15J1-p
20. Q-ball signal shield terminate	Shield	0 vdc	20	Q ball	A15J1-d
21. Pyro switches indicate arm	Monitor	28 vdc	20	Sequencer	A15J2-S
22. Pyro switches indicate safe	Monitor	28 vdc	20	Sequencer	A15J2-R
23. Pyro buses arm command	Power	28 vdc	20	S-I GSE	A15J2-L
24. Pyro bus A safe command	Power	28 vdc	20	S-I GSE	A15J2-M
25. Pyro bus B safe command	Power	28 vdc	20	S-I GSE	A15J2-N
26. Pyro bus A indicate ON	Monitor	28 vdc	20	Sequencer	A15J2-T
27. Pyro bus B indicate ON	Monitor	28 vdc	20	Sequencer	A15J2-U
28. Logic switches indicate arm	Monitor	28 vdc	20	Sequencer	A15J2-k

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TABLE 7-2 BOTTERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONT)

Adapter/Saturn IU interface (Cont.)	Function	Voltage range, v d-c	Wire gage	Origin	Connector and pin
29. Logic switches indicate safe	Monitor	28	20	Sequencer	A15J2-e
30. Logic buses arm command	Power	28	20	S-I GSE	A15J2-b
31. Logic bus A safe command	Power	28	20	S-I GSE	A15J2-c
32. Logic bus B safe command	Power	28	20	S-I GSE	A15J2-P
33. Logic bus A indicate ON	Monitor	28	20	Sequencer	A15J2-m
34. Logic bus B indicate ON	Monitor	28	20	Sequencer	A15J2-n
35. LES indicate power	Power	28	20	S-I GSE	A15J2-f
36. LET jettison command power	Power	28	20	Sequencer	A15J2-g
37. LET jettison command	Signal	28	20	TU	A15J2-h
38. LET jettison indicate fire	Monitor	28	20	Sequencer	A15J2-V
39. LET jettison indicate safe	Monitor	28	20	Sequencer	A15J2-Z
40. LES sequencer common (-)	Return	0	20	Sequencer	A15J2-a
41. Shield terminate	Shield	0	20	TU	A15J2-i
42. Instrument bus A battery power off command	Holding	28	20	S-I GSE	A15J3-b

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TABLE 7-2 BOILERPLATE 15 ELECTRICAL UMBILICAL FUNCTIONS (CONCLUDED)

Adapter/Saturn IU interface (Concluded)	Function	Voltage range, v d-c	Wire gage	Origin	Connector and pin
43. Instrument bus B battery power off command	Holding	28	20	S-I GSE	A15J3- <u>c</u>
44. Instrument bus control common	Return	0	20	PCB	A15J3- <u>a</u>
45. Launch-escape tower jettison command power	Power	28	20	Sequencer	A15J3- <u>e</u>
46. Launch-escape tower jettison command	Signal	28	20	IU	A15J3- <u>f</u>
47. Lift-off indication power	Power	28	20	Sequencer	A15J3- <u>h</u>
48. Lift-off indication	Signal	28	20	IU	A15J3- <u>j</u>
49. Shield terminate	Shield	0	20	IU	A15J3- <u>g</u>

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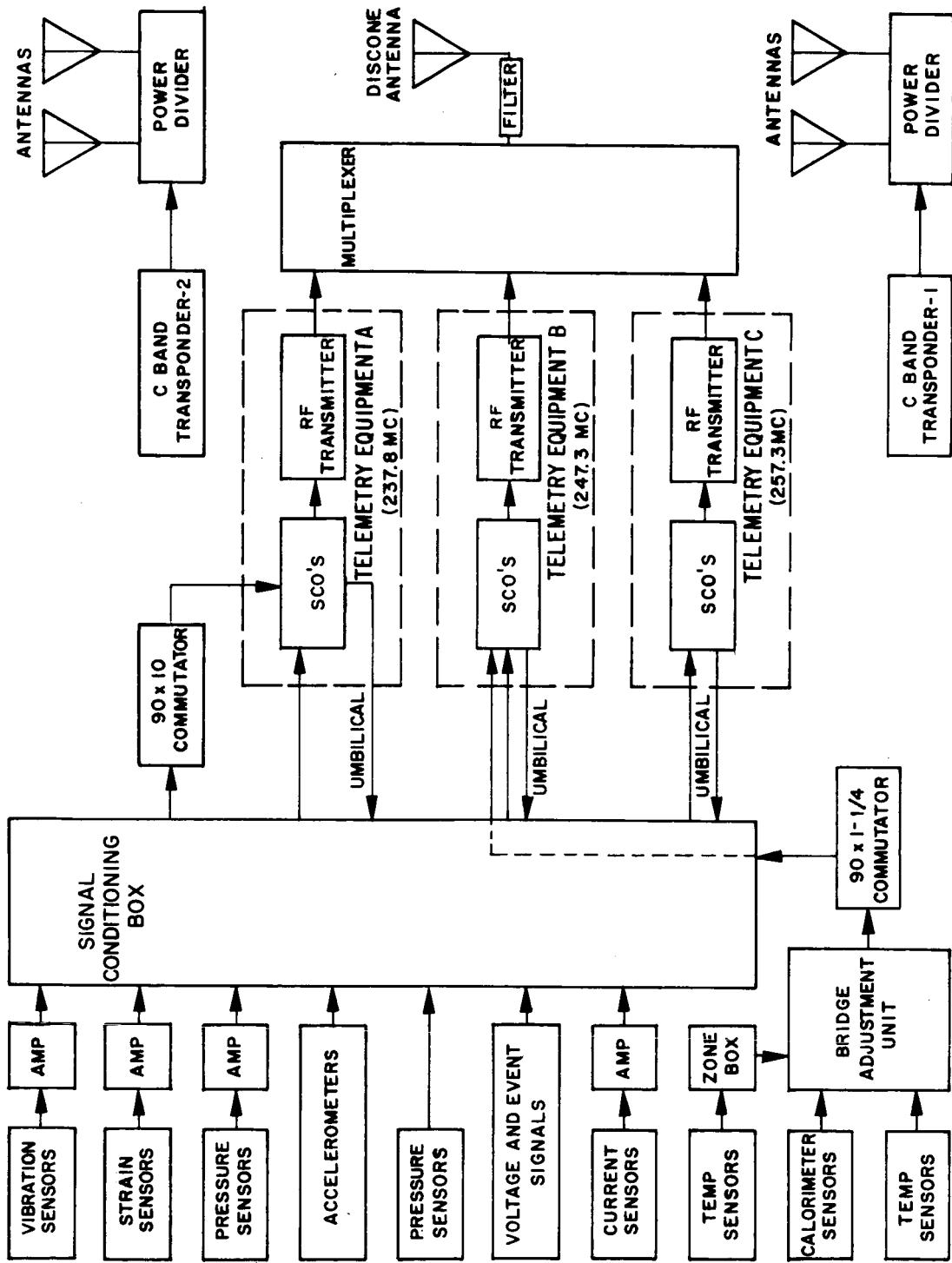
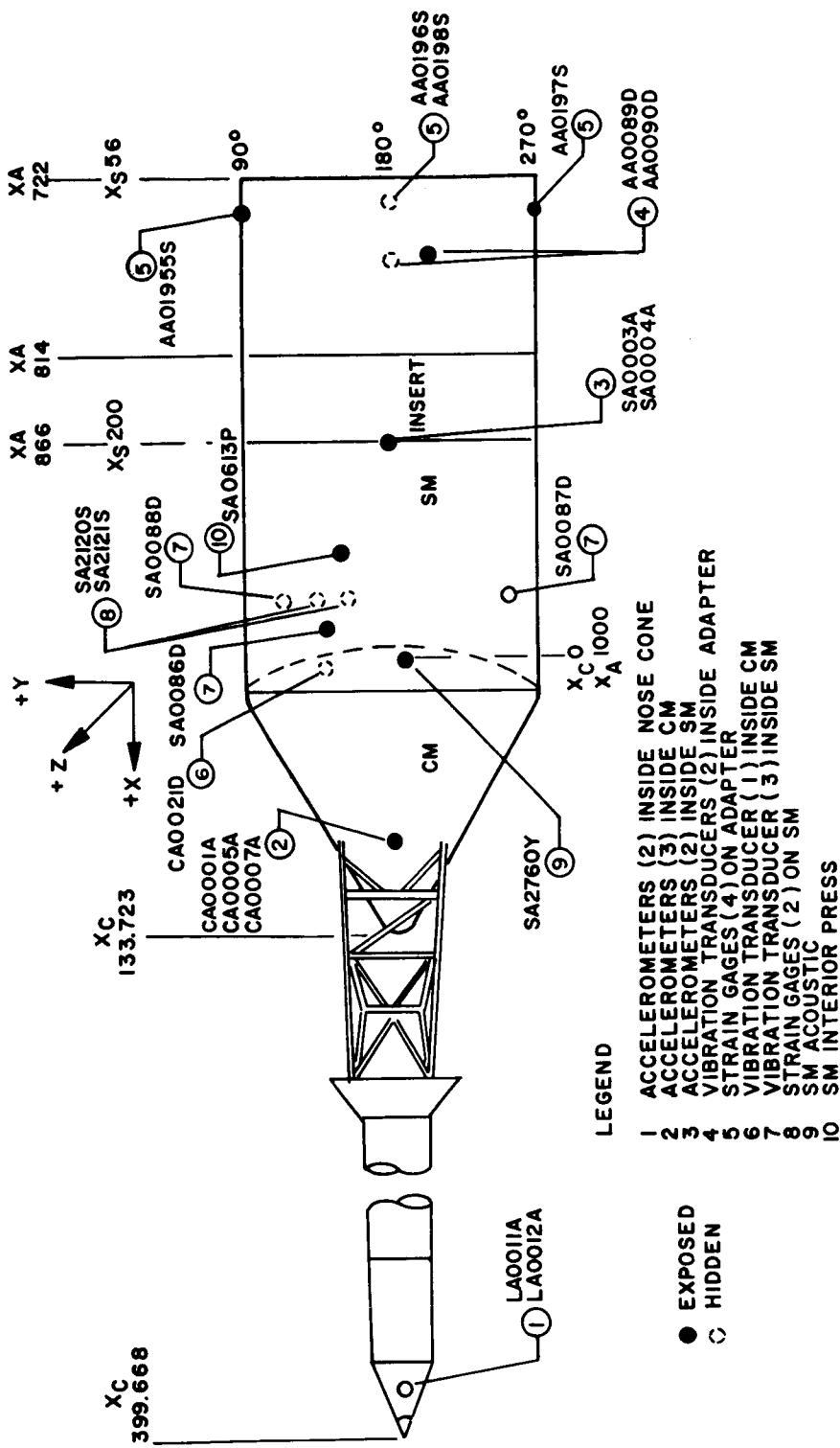


Figure 7-1.-Boilerplate 15 research and development communications and instrumentation subsystem.

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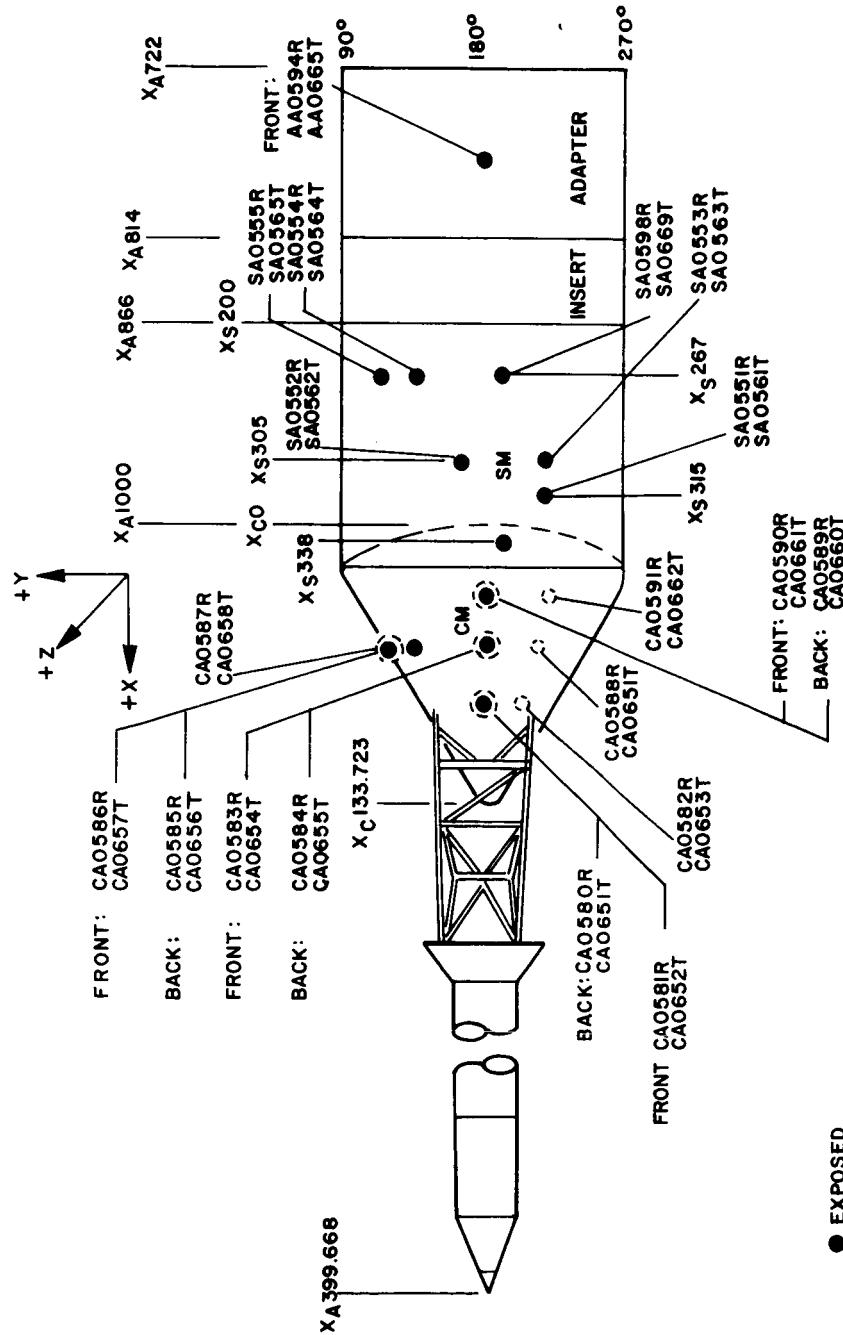
NOTES

- I. THE MEASUREMENT LOCATIONS ARE REFERENCED FROM THE +Z AXIS ($+Z=0^\circ$) AND THE MEASUREMENT ANGLE INCREASES AS THE MEASUREMENT LOCATION CHANGES PROGRESSIVELY FROM THE +Z AXIS TO THE +Y AXIS.
 2. SEE THE MEASUREMENT LISTS FOR SPECIFIC MEASUREMENT LOCATIONS
 3. THE DIAGRAM IS NOT DRAWN TO SCALE

(a) Accelerometers, vibration transducers, and strain gages

Figure 7-2.—Boilerplate 15 measurement locations.

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LEGEND

CALORIMETERS (20) AND CALORIMETER BODY TEMPERATURE (20)

NOTES:

1. THE MEASUREMENT LOCATIONS ARE REFERENCED FROM THE +Z AXIS (+Z = 0), AND THE MEASUREMENT ANGLE INCREASES AS THE MEASUREMENT LOCATION CHANGES PROGRESSIVELY FROM THE +Z AXIS TO THE +Y AXIS
2. SEE THE MEASUREMENT LISTS FOR SPECIFIC MEASUREMENT LOCATIONS
3. THE DIAGRAM IS NOT DRAWN TO SCALE

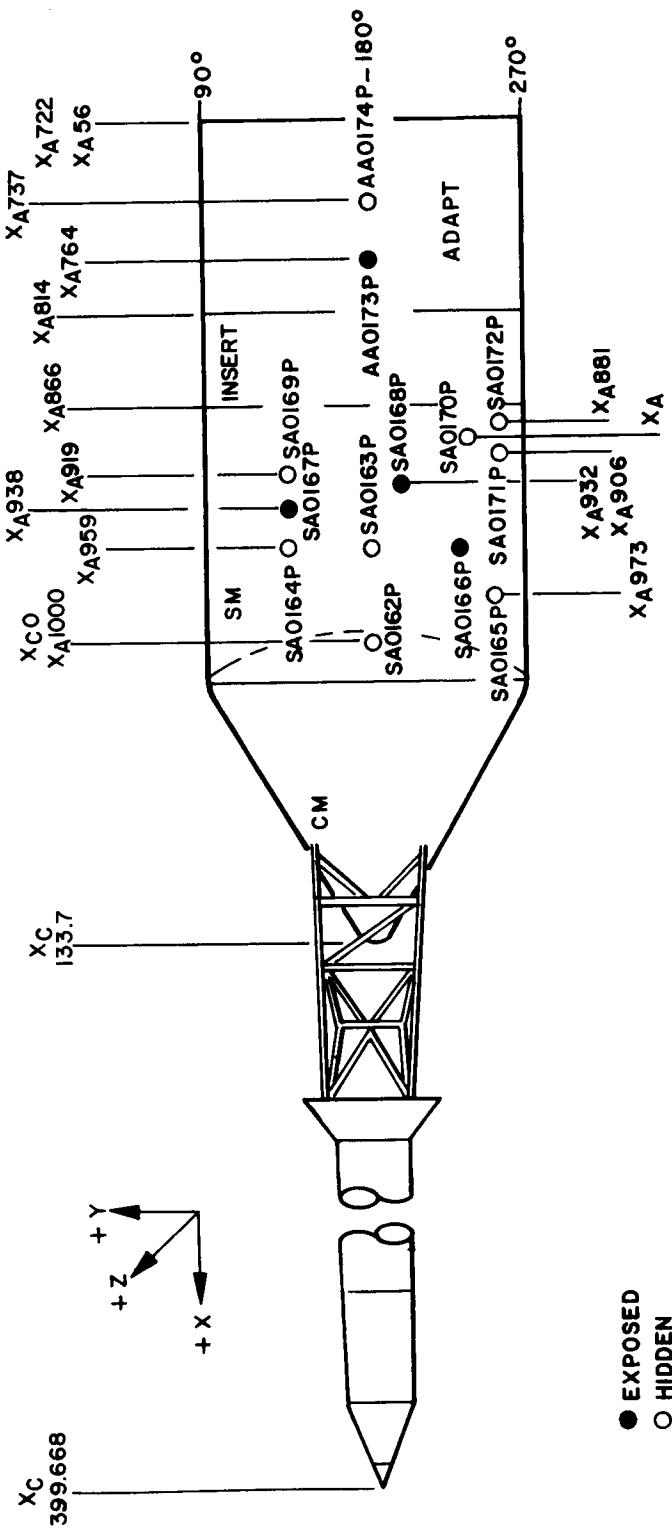
(b) Calorimeter and calorimeter body temperatures

Figure 7-2. – Continued

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**LEGEND:
13 FLUCTUATING PRESSURES**

NOTES:

1. THE MEASUREMENT LOCATIONS ARE REFERENCED FROM THE +Z AXIS (+Z = 0°), AND THE MEASUREMENT ANGLE INCREASES AS THE MEASUREMENT LOCATION CHANGES PROGRESSIVELY FROM THE +Z AXIS TO THE +Y AXIS
2. SEE THE MEASUREMENT LISTS FOR SPECIFIC MEASUREMENT LOCATIONS
3. THE DIAGRAM IS NOT DRAWN TO SCALE

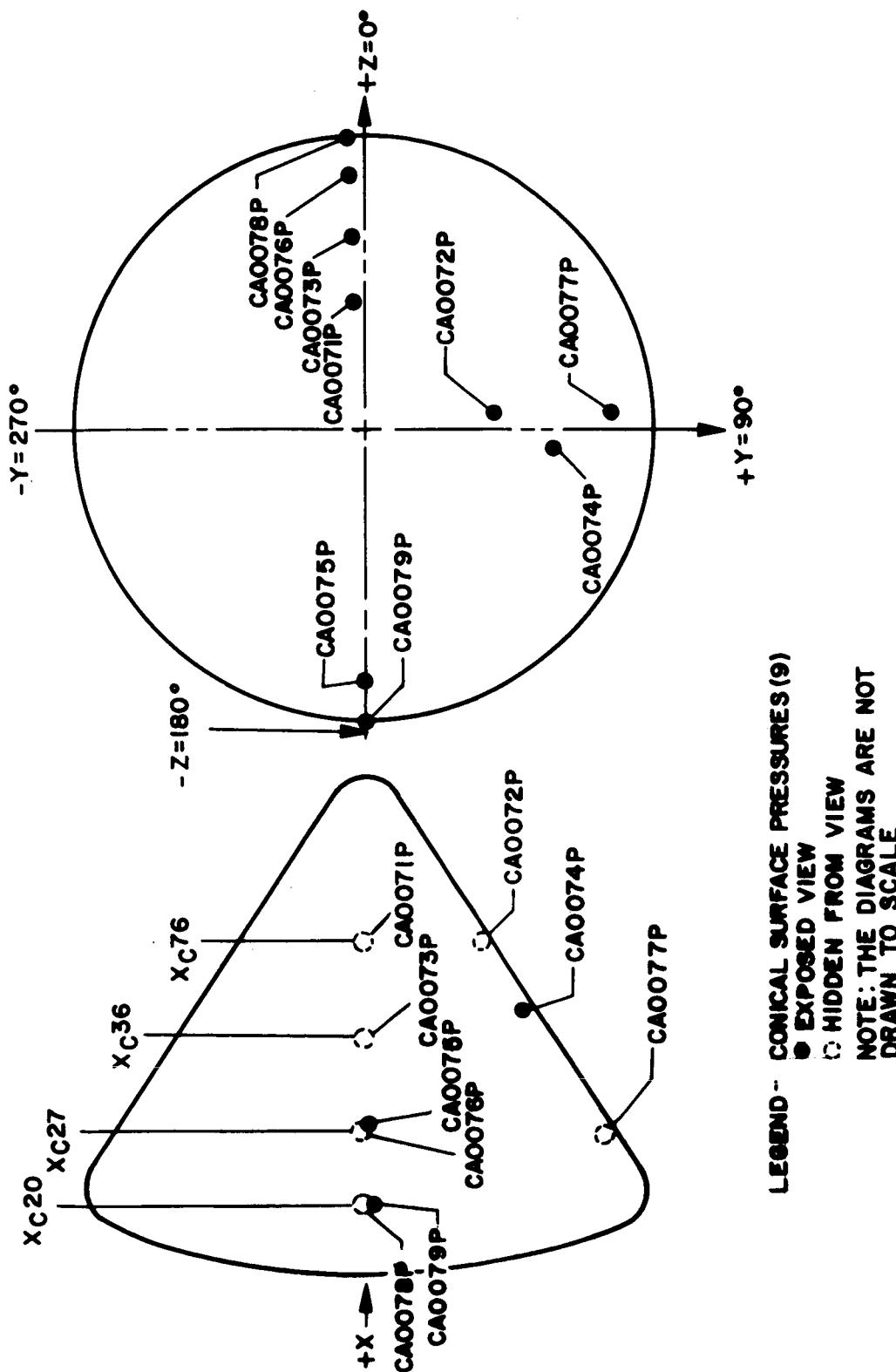
(c) Fluctuating pressure transducers

Figure 7-2. – Continued

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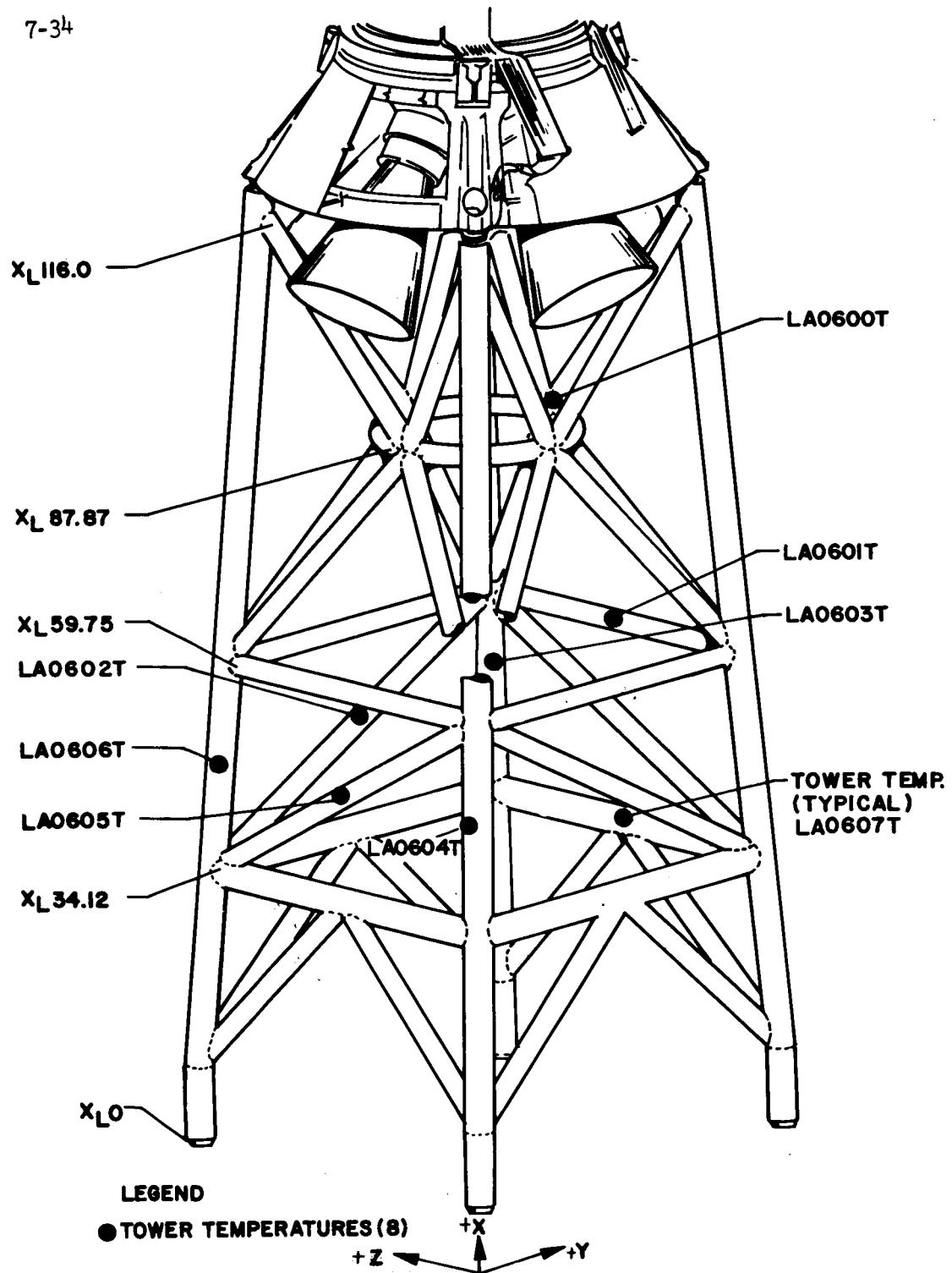
(d) Command module static pressure measurement locations

Figure 7-2. – Continued

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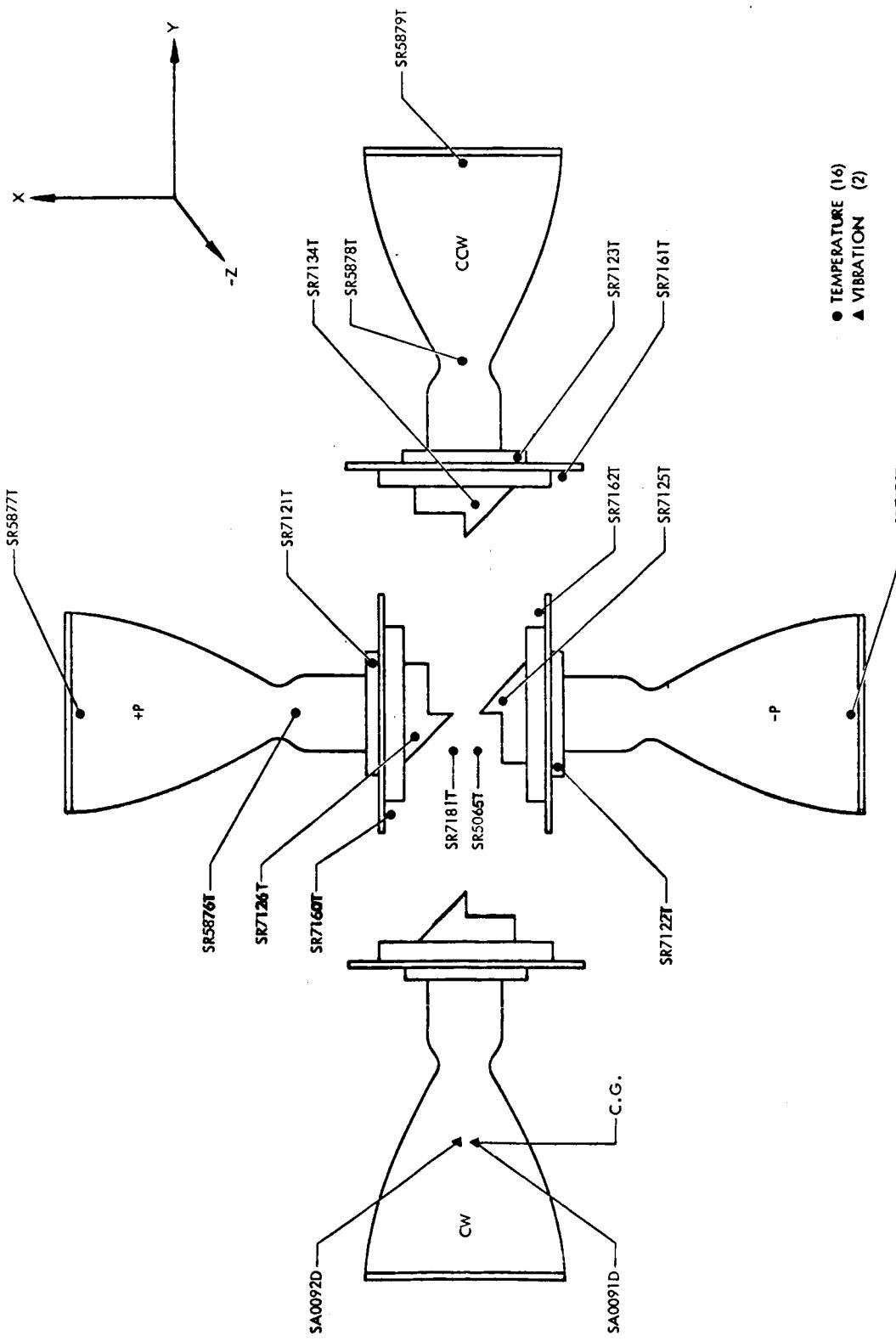


(e) LES tower temperature measurement locations

Figure 7-2. - Continued

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(f) Service module RCS quadrant A temperature and vibration transducers

Figure 7-2. - Concluded

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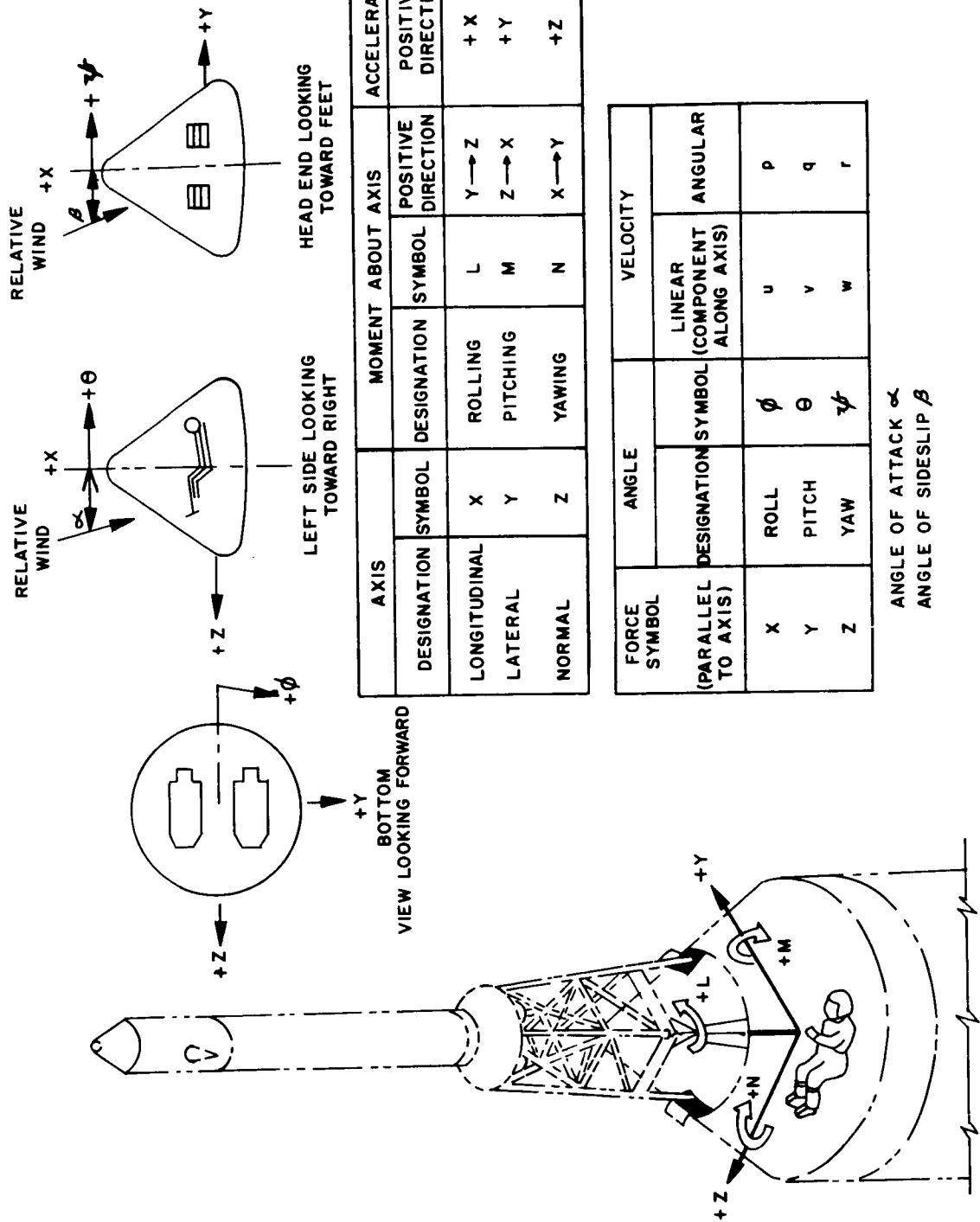


FIGURE 7-3-REFERENCE AXIS SYSTEM.

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8.0 TRACKING AND SUPPORT DATA REQUIREMENTS

See reference 3.

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9.0 PRELAUNCH OPERATION

9.1 Test Preparation, NAA, S&ID, Downey

See reference 3.

9.2 Test Preparation, Kennedy Space Center

A general description of typical activities can be found in NASA Project Apollo Working Paper No. 1085A - Mission Directive for BP-13. The significant difference in the prelaunch checkout of BP-15, compared to that of BP-13, is that the BP-15 integrated systems checkouts were deferred to the pad operations with an accompanying saving of time during the hangar checkout. Spacecraft Checkout Operations on the launch pad remain essentially the same as for BP-13. See figure 9-1.

9.3 Launch Day Activities

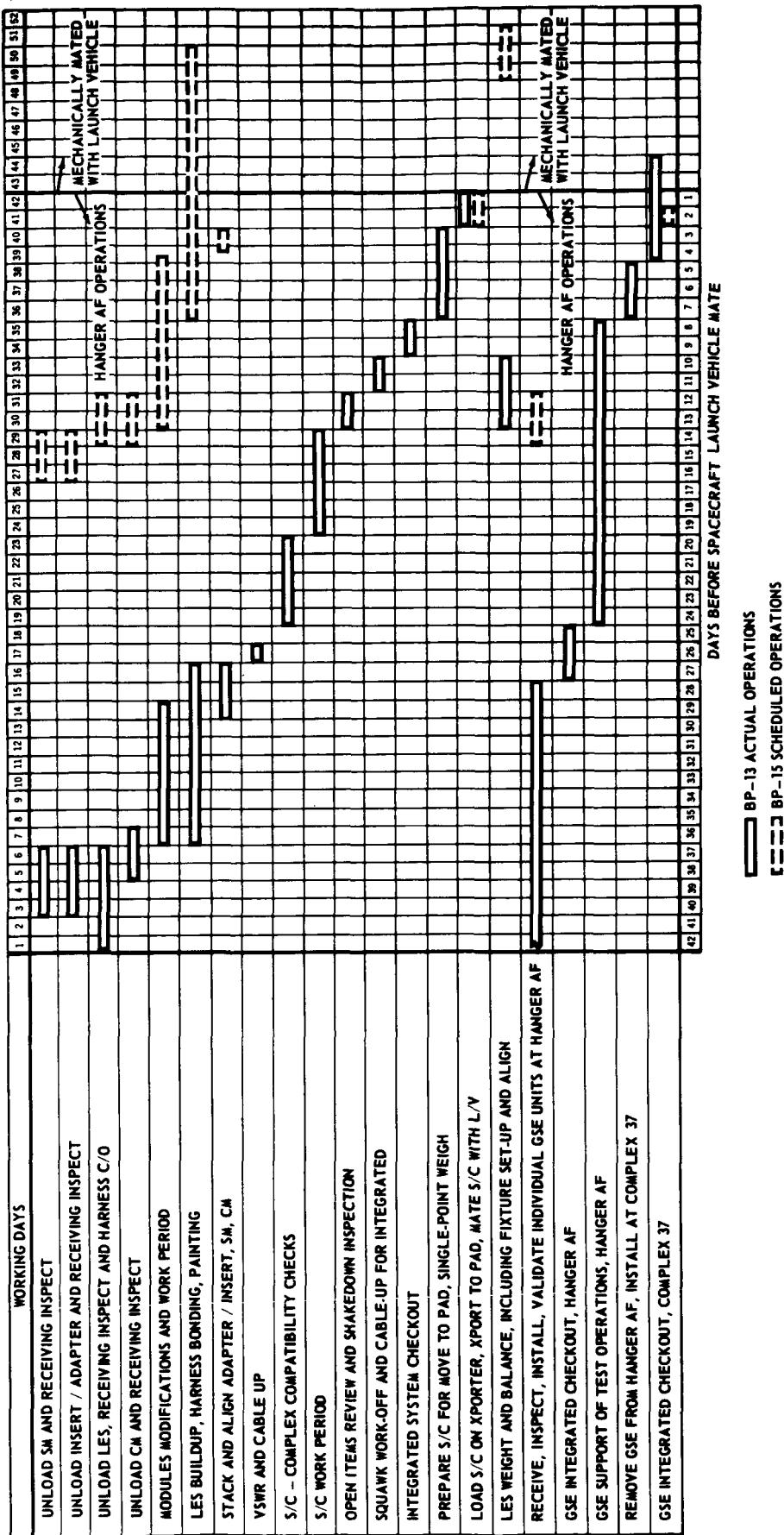
By the start of countdown, the onboard systems will have been checked and tested to assure that the systems are in operative condition. The LES system will have been installed with pyrotechnics shorted. Batteries will have been installed, checked, and unloaded.

The countdown activities as presently envisioned are presented in table 9-1. The official countdown is the responsibility of MSC-FO, MSFC, and KSC and will be coordinated and written by MSC-FO and KSC.

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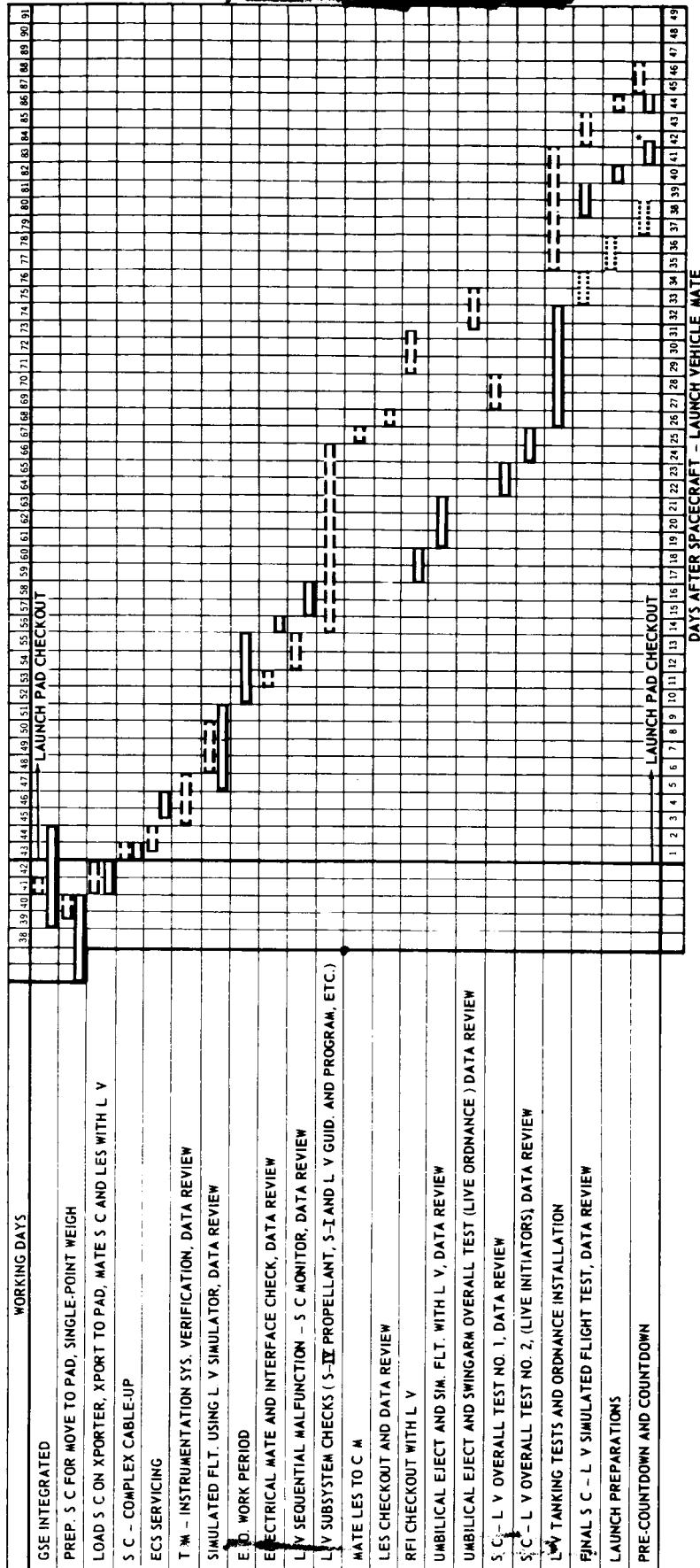


(a) Hangar portion (prior to mating with launch vehicle)

Figure 9-1. - Checkout schedule of BP-15 at KSC, showing comparison with that of BP-13.

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(b) Launch-pad portion (after mating with launch vehicle)

Figure 9-1.- Concluded.

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TABLE 9-1.- BOILERPLATE 15 COUNTDOWN ACTIVITIES

Time Hr:min:sec	Activity	Location
T-6:00:00	Ordnance crew only on pad.	Pad-37B
	Check continuity; install launch-escape and pitch-motor initiators (completed by T-5:40:00).	Spacecraft
T-5:40:00	Install conditioned solid propellant turbine spinners (completed by T-4:40:00).	S-I
T-4:30:00	Install hypergol cartridges (completed by T-4:10:00).	S-I
T-4:10:00	Check continuity; install separation initiators and connect electrical plugs (completed by T-3:35:00).	S-IV
	Check continuity, install spinner, initiators, destruct initiators, and connect electrical plugs (completed by T-3:30:00).	S-I
T-3:30:00	Verify systems (completed by T-2:40:00). 1. ECS pump check 2. TM checks 3. Power transfer checks 4. Beacon checks 5. Sequencer check Connect LES and sequencer electrical plugs.	Spacecraft
T-3:05:00	Fill LO ₂ tank to 98 percent (completed by T-2:40:00).	S-IV
T-2:46:00	Fill LO ₂ tank to 100 percent (completed by T-2:25:00).	S-I
T-2:40:00	Remove carry-on GSE (completed by T-2:30:00).	Spacecraft
	Replenish LO ₂ tank to 99.75 percent (stop at T-2:20:00)	S-IV
T-2:30:00	Close hatch (completed by T-2:20:00).	Spacecraft
T-2:20:00	Remove gantry (completed by T-1:30:00).	Pad-37B
T-1:30:00	Clear launch pad of personnel. Fill LO ₂ to 100 percent.	S-I

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TABLE 9-1.- BOILERPLATE 15 COUNTDOWN ACTIVITIES (CONT)

Time, Hr:min:sec	Activity	Location
T-1:00:00	Start LO ₂ replenish.	S-I
T-0:50:00	Start final fuel level correction (complete by T-0:40:00)	S-I
T-0:45:00	Start fuel pressurization	S-I
T-0:40:00	Final fuel level correct	S-I
	Start spacecraft GN ₂ purge.	Spacecraft
	Start LH ₂ tanking to 95 percent	S-IV
T-0:35:00	Turn on hydraulic power and gimbal engines	S-IV
T-0:30:00	Turn on Q-ball heater.	Spacecraft
T-0:25:00	Turn on ECS fan and pump	Spacecraft
T-0:20:00	Turn on instrumentation bus, TM, and transponder	Spacecraft
T-0:05:20	Pressurize fuel tank	S-I
	Check engines gimballed and return to null.	S-IV
	Replenish LH ₂ to 99 percent	S-IV
T-0:04:00	Change power over to internal, ECS to internal Arm pyro busses.	Spacecraft Spacecraft
T-0:03:30	Turn on ECS ready light	Spacecraft
	Turn on LES ready light	Spacecraft
T-0:03:00	Turn TM power to high	Spacecraft
T-0:02:50	Calibrate TM.	Spacecraft
T-0:02:31	Firing command	S-I
T-0:02:30	Begin power transfer	S-IV
	Start LO ₂ pressurization	S-IV

TABLE 9-1.- BOILERPLATE 15 COUNTDOWN ACTIVITIES (CONT)

Time, Hr:min:sec	Activity	Location
	Start LO ₂ bubbling.	S-I
T-0:02:20	Turn RF ready light on.	Spacecraft
T-0:02:10	Start LH ₂ replenishing to 100 percent.	S-IV
T-0:02:00	Turn spacecraft ready light on.	Spacecraft
T-0:01:28	Turn LO ₂ bubbling off.	S-I
	Start LO ₂ pressurization.	S-I
T-0:00:45	Start S-IV calibration.	S-IV
	Complete LO ₂ pressurization	S-IV
	Complete LO ₂ replenishing	S-IV
	Complete LH ₂ replenishing	S-IV
T-0:00:35	Complete S-IV calibration	S-IV
T-0:00:25	Start S-I power transfer	S-I
T-0:00:05	Complete LO ₂ pressurization	S-I
	Complete power transfer	S-I
T-0:00:00	Ignition command	S-I
T+0:00:01	Engine Start	S-I
	Umbilical disconnect	Spacecraft and S-I
	Module GN ₂ purge-off	Spacecraft
T+0:00:3.42	Hold down release	S-I

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10.0 TEST MANAGEMENT ORGANIZATION

10.1 Downey Test Preparation Organization

The Downey Test Preparation Organization for the spacecraft is shown in figure 10-1 where:

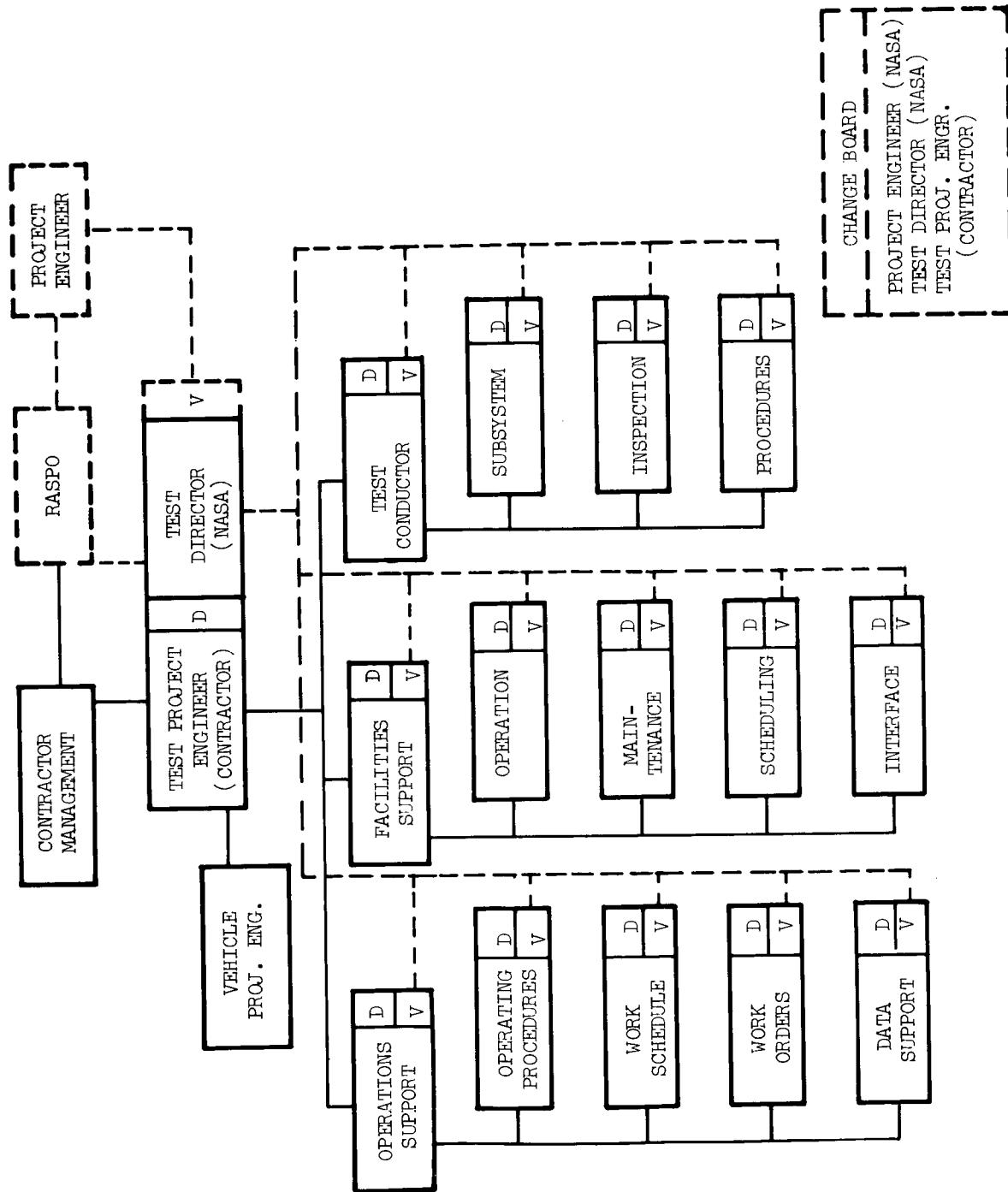
- (a) NAA, S&ID, Downey is denoted by D.
- (b) NASA is denoted by V.

10.2 Preflight Checkout Team Functional Relationships

The functional relationships of the Apollo BP-15 preflight checkout team are shown in figure 10-2.

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Figure 10-1.- NAA Downey checkout team functional relationships

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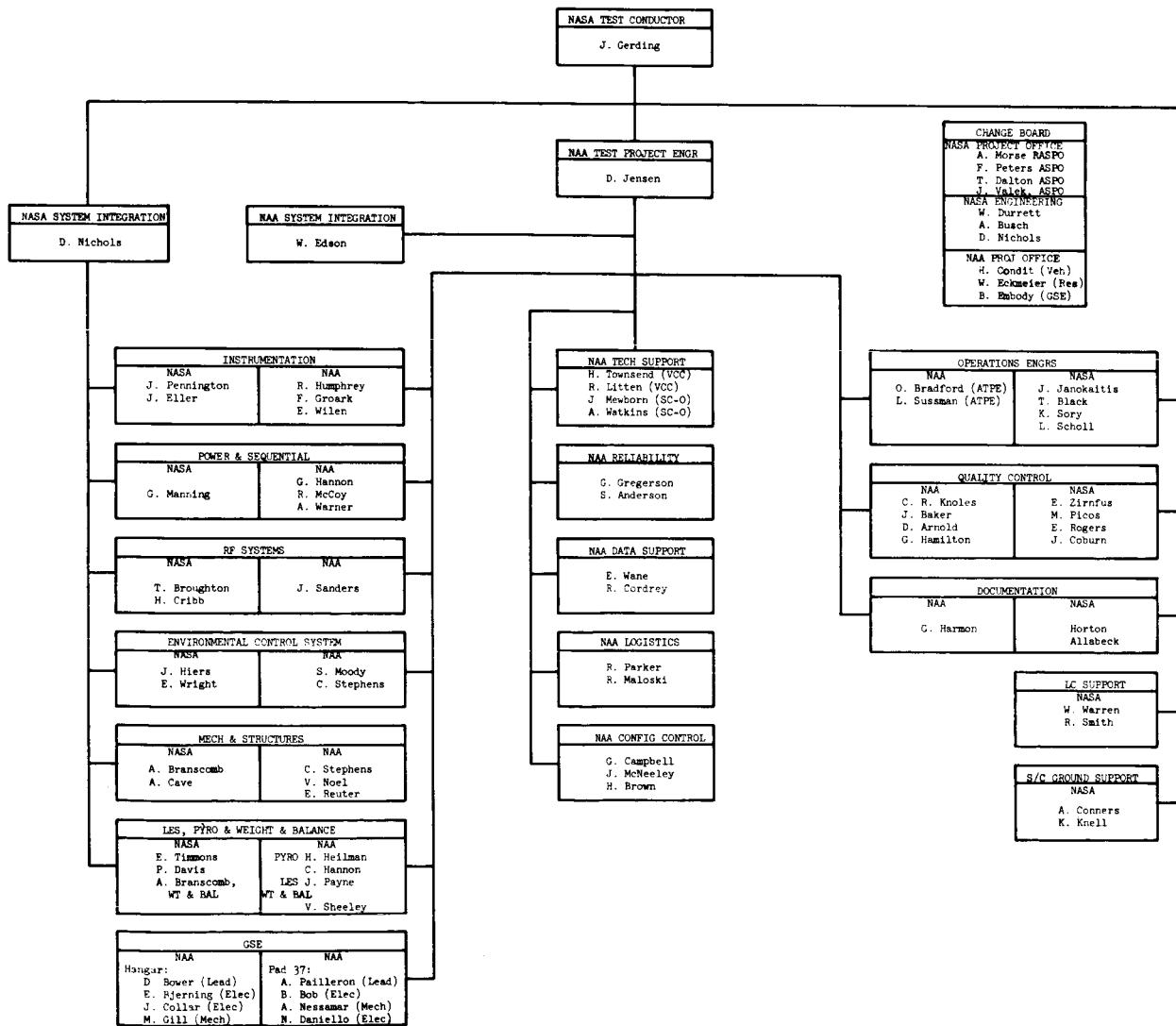


Figure 10-2.- Apollo BP-15 preflight checkout team functional relationships

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11.0 RECOVERY REQUIREMENTS

There are no recovery requirements for the BP-15 spacecraft.

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12.0 LAUNCH DAY REQUIREMENTS

Weather Requirements for Launch

There are no minimum weather requirements established by spacecraft considerations for the launch, except that the cloud cover must permit optical tracking to 300,000 feet. The weather requirements for the launch of BP-15 will be dictated by the launch vehicle restrictions.

Reference 1 details the restraints.

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13.0 PAD AND RANGE SAFETY REQUIREMENTS

13.1 Pad Safety

All provisions of the "General Range Safety Plan, Volume I", AFMTC Pamphlet No. 80-2 (ref. 6), are applicable unless specifically excepted, modified or supplemented.

13.2 Range Safety

Range safety requirements shall be in accordance with the "General Range Safety Plan, Volume II," AFMTC Pamphlet No. 80-2 (ref. 6). This document supplements the general safety policies and procedures prescribed in AFMTC Regulation 80-9. (ref. 7)

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14.0 DATA HANDLING, ANALYSIS, AND REPORTING

See reference 3, except that the considerations for preparation of the Postlaunch Report at the launch site are being re-examined. At the time of publication of this Mission Directive, a decision had not been made as to whether the Postlaunch Report major effort would be at the launch site (MSC-FO) or at Manned Spacecraft Center, Houston.

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15.0 GROUND SUPPORT EQUIPMENT

15.1 General

See reference 3.

15.2 Ground Support Equipment List

See reference 1 with the following exceptions:

Delete: (1) C14-180 Electrical Cable Set (ETR Pad 34)

(2) H14-154 DC Electronic Weighing Kit

Add: (1) A14-134 Crane Control, auxiliary (10-ton)

(2) A14-135 ECS Protective Cover

(3) A14-154 d-c Digital Indicator

(4) C14-166 R&D C-Band antenna coupler

(5) H14-095 Access Stand, Tower Area

(6) H14-161 LE motor propellant grain inspection kit

(7) S14-091 Battery Conditioner

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16.0 REFERENCES

1. "Operations Requirements No. 2400". National Aeronautics & Space Administration. (Confidential)
2. "Apollo Flight Mission Assignments", M-DE 8000.005 B. National Aeronautics & Space Administration. (Confidential)
3. NASA Project Apollo Working Paper No. 1085A - Mission Directive for EP-13. (Confidential)
4. "Apollo Spacecraft Requirement Specification", SID 62-700-2. North American Aviation, Space and Information Systems Division. (Confidential)
5. "Apollo Measurement Requirements, Boilerplate 15, Apollo Mission A-102", National Aeronautics & Space Administration - MSC. (Unclassified)
6. "General Range Safety Plan, Volumes I & II", AFMTC Pamphlet No. 80-2. (Unclassified)
7. AFMTC Regulations 80-9. (Unclassified)

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